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This thesis consists of an in-depth analysis of characterized contract incentive usage among Construction Industry Institute member companies and overall impact on project performance in the areas of cost, quality, safety, and schedule. Data were collected from CII member companies through surveys conducted by CII Implementation Feedback Team 99-1 and by utilizing the CII Benchmarking and Metrics Database. The policy implications of the findings in this research are given for both public and private procurement agencies.

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Innovative Construction Contract Incentives

by

Jeffrey Larry Milhorn, B.S.C.E.

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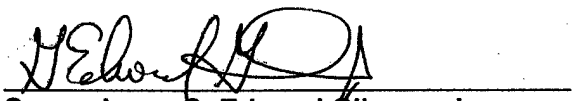

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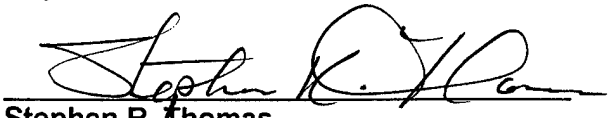

Stephen R. Thomas

Dedication

This thesis is dedicated to my beautiful wife Debbie and my three children Chase, Lindsay, and Kailey. Without your love, sacrifice and devotion, I would not have accomplished all that I strive for. I would also like to thank my parents for their love, lifelong support and encouragement, and express my gratitude for their gift of education.

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October 1999

Abstract

Innovative Construction Contract Incentives

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The University of Texas at Austin, 1999

Supervisor: G. Edward Gibson, Jr.

This thesis consists of an in-depth analysis of characterized contract incentive usage among Construction Industry Institute member companies and overall impact on project performance in the areas of cost, quality, safety, and schedule. Data were collected from CII member companies through surveys conducted by CII Implementation Feedback Team 99-1 and by utilizing the CII Benchmarking and Metrics Database. The policy implications of the findings in this research are given for both public and private procurement agencies.

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Chapter 1: Introduction

Incentives are a basic part of any construction contract. When properly integrated, incentives can enhance project performance, promote innovation and motivational behavior, and establish a "win-win" environment within which all project participants can excel. Additionally, use of incentives can diminish the adversarial relationships that so commonly frequent the construction industry, and actually facilitate a more harmonious team-building environment.

Successful project performance is difficult to evaluate, regardless if measured in terms of cost, quality, safety, schedule or any other parameter. Results are influenced by many factors, including: (1) project characteristics, (2) economic conditions, (3) environmental influence, (4) political climate, and (5) performance of participating organizations and key personnel. A major challenge within the construction industry is identification, development, and promotion of practical ways to increase construction cost effectiveness. Properly designed and administered incentive plans represent such a mechanism (Ibbs and Abu-Hijleh 1988).

The purpose of this report is to first characterize incentive use among CII member companies and evaluate their overall effectiveness on the four performance parameters of cost, quality, safety, and schedule. Second, a quantitative characterization of incentive use by type (positive, negative, or both) will be determined through use of CII's Benchmarking and Metrics Database.

Aligning both owner and contractor objectives is widely thought to be a catalyst for better project performance. For this very reason, owners employ contract incentives in order to persuade the contractor to adopt the owner's goals. The scope of this thesis is to research the extent of use and consequent effects of construction contract incentives by CII member

companies, including both owners and contractors. The relative use of incentives will be characterized, and a subsequent quantitative assessment performed. Additionally, the impacts of incentive use on cost, quality, safety, and schedule will be investigated.

This research will be accomplished through use of data collected and analyzed by the Construction Industry Institute (CII) Implementation Feedback Team 99-1 and by CII's Benchmarking and Metrics Database. This database includes responses from both owners and contractors.

Objectives that this study aims to accomplish include:

1. Understand the relative degree of use and effectiveness of various contract incentives.
2. Gain a better insight into the overall impact of contract incentives on cost, quality, safety, and schedule.
3. Identify breakthrough approaches to compensate contractors for performance, based on mutually determined objectives and use of respective incentives to accomplish such objectives.

This research should provide both the public and private owner with a foundation to aid them in their decision to use certain types of contract incentives.

Positive incentives likely have a different impact on project performance as opposed to negative incentives (penalties, liquidated damages, etc.). The types of incentives (positive, negative, both) employed by owners and contractors will be examined for their relative significance and impending results.

There are several specific research questions that will be answered in this thesis. They are as follows:

1. What contract incentives are most widely used by CII member companies?
2. Which incentives tend to have the most positive impact on the four project performance parameters of cost, quality, safety, and schedule?
3. Where do diverging opinions exist between Owners and Contractors on incentive use and resulting impact on project performance?
4. Do multiple-parameter incentives have a greater impact on project performance than single-parameter incentives?
5. To what degree are positive, negative, or a combination of both types of incentives used to impact cost, quality, safety, and schedule performance?

Chapter 2 of this report will include an extensive review of past research and literature concerning incentives. Chapter 3 describes the methodology by which the research was accomplished to include a brief discussion concerning the survey instruments used by CII Implementation Feedback Team 99-1, the CII Benchmarking and Metrics Database, as well as the analysis procedures. Chapter 4 presents the analysis of the characterized incentive usage by CII member companies. Chapter 5 presents the analysis of the performance data as consolidated in the Benchmarking and Metrics Version 3.0 Database. Lastly, conclusions and recommendations on the use of contract incentives will be presented in Chapter 6.

Chapter 2: Background

Much of the data for this research was collected in conjunction with other Construction Industry Institute activities. Data were both gathered and analyzed by a CII Implementation Feedback Team with assistance from the author and data from the CII Benchmarking and Metrics Database were evaluated. As such, a description of CII and its overall purpose is presented below. Previous research will also be described as it relates to incentive strategies as identified by CII Research Team 114. Additionally, a concise review of Jayson Mitchell's Thesis will also be presented - "Impact of Incentives on Project Performance."

2.1 THE CONSTRUCTION INDUSTRY INSTITUTE

The Construction Industry Institute is a research organization with a singular mission: improving the cost effectiveness of the capital facility delivery process and the competitiveness of its member companies. In 1983, the CII founding members were convinced of the serious need for construction-related research. This need was clearly identified by The Business Roundtable Construction Industry Cost Effectiveness Project, a five-year study that produced over 200 recommendations for improving the industry. One recommendation was to establish a national research center for construction. The founding members then established CII at the University of Texas, where today it is considered the national forum for construction research (CIInetA 1999).

2.2 RESEARCH TEAM 114

Each year the CII Board of Advisors nominates specific areas of research to be conducted based on current construction industry trends and/or weaknesses. In 1996, CII Research Team 114 was established to investigate

and develop breakthrough approaches to contractor compensation. Founded on the premise that traditional engineering and construction contracts perpetuate competing interests between owners and contractors, the team began with the goal to rethink contractor compensation in order to align contractor performance more closely with owner objectives. Compensation was broadly interpreted to include reward, recognition, money payment, future opportunities, expanded roles and reduced risk (CII 1998).

After conducting fourteen structured interviews and a national workshop, the research team identified 32 compensation strategies. The 32 strategies were then stratified and grouped into the ten categories as indicated below.

A. Development of Incentive Plans
B. Selection of Performance Measures
C. Application of Performance Measures to Incentive Calculation
D. Project Team Member Incentives
E. Incentive Effect Improvement Through Increased Contractor Control
F. Maintenance of Incentive Targets in Long-Term Relationships
G. Promoting Long-Term Contractor Focus on Owner Objectives
H. Future Work as a Motivator
I. Alternative Compensation Units
J. Cash Flow Enhancements

The team found innovative contracting strategies that go well beyond traditional concepts of alliances, team autonomy, and incentive contracting. No single breakthrough strategy or set of metrics, however, was applicable to all projects. They found the compensation plans to be highly individualized to the specific project and the personalities and philosophies of project leaders

that craft the contract. Additionally, the team realized that the application of innovative contractor compensation strategies should not be considered an "end all" solution to project performance improvements. Such strategies instead should be considered one more important tool in a project team's "tool kit" to be applied in conjunction with other CII best practices such as partnering, team building, team alignment, open communications, setting project objectives, and pre-project planning (CII 1998).

2.3 IMPLEMENTATION FEEDBACK TEAM 99-1

In 1998, CII formed Implementation Feedback Team 99-1 to further explore the use of those Contractor Compensation Strategy recommendations and the resulting impact on project results. The purpose of this effort was to assist member organizations in realizing increased competitive advantage through the adoption of a more effective and efficient capital project management process. The Implementation Feedback Team reported their findings at the 1999 CII Annual Conference and Construction Project Improvement Conference. IFT 99-1's charter to the Board of Advisors was structured as follows:

Purpose. To evaluate the success and the benefits that CII member organizations have realized in implementing Innovative Contractor Compensation. This information was collected, analyzed and reported at the Annual Conference and the Construction Project Improvement Conference, to inform and assist other member organizations to realize those benefits. The team consisted of experienced industry practitioners who were interested in successful implementation of Innovative Contractor Compensation. Research assistance was provided by the author in the collection, synthesis and analysis of data from CII member organizations.

Deliverables. The Innovative Contractor Compensation Team presented their findings at the CII Annual Conference and the Construction

Project Improvement Conference. The team also produced a brief written report of their findings, which was distributed to CII member organizations (CII 1999).

Functions of the Team. The team reviewed applicable research products developed by CII and conducted an assessment of the level of utilization of innovative contractor compensation activities and reports. Survey data describing the use of the CII principle, together with information on both successful and unsuccessful implementation project effort was gathered. This information was analyzed, and follow-up interviews were conducted in selected cases to collect additional information specific to cases of highly successful implementation. Difficulties reported with implementation of innovative contractor compensation were equally examined to inform the membership on lessons learned.

Level of Activity. The team met on eight separate occasions, and the effort was completed in 11 months. Information was also exchanged through four conference calls and numerous electronic messages (e-mail).

2.4 BENCHMARKING AND METRICS AT CII

In addition to information gathering through use of research teams, the CII Board of Advisors established a Benchmarking and Metrics (BM&M) Committee in 1993 who in turn designed the BM&M Database.

The CII BM&M Database is a computer-based anthology of descriptive project data representing over 700 construction projects completed between 1991 and 1999. Its primary purpose is to provide industry performance norms, quantify the use and value of "best practices," and to help focus CII research and implementation efforts. The data gathered for the database are used to develop performance norms, to identify trends, and to correlate the execution of project management processes to project outcomes.

Benefits of the CII benchmarking program are numerous. Participation provides companies access to a user friendly, resource efficient, statistically credible benchmarking system that provides quantitative data essential for the support of cost/benefit analysis. Participants can assess their projects and company performance and compare this performance against a large sample of projects from some of the industry's most reputable firms. Potential for improvement and actual cost savings can be quantified supporting further company self-analysis and improvement programs (CIInetB 1999).

CII owner and contractor companies contributed the information in the database in response to three consecutive surveys submitted to them in 1996, 1997, and 1998. The three surveys identified as Versions 1.0, 2.0, and 3.0 respectively, were each presented in the form of two questionnaires - one for owners and the other for contractors. The owner and contractor questionnaires posed the same set of questions but from inherently different perspectives with some questions exclusively targeted for owner response. As stated in Chapter 1, all of the data utilized for analysis in the latter half of this thesis was obtained from CII's Benchmarking and Metrics Version 3.0 Questionnaire.

2.5 IMPACT OF INCENTIVES ON PROJECT PERFORMANCE

In 1998, Jayson D. Mitchell published a thesis that focused on the quantitative results as obtained from the Benchmarking and Metrics (BM&M) Database. He sought to correlate incentive usage within owner-driven contracts with relative impact on a project's "Recordable Incident Rate" (RIR) and "Lost Workday Case Incident Rate" (LWCIR), cost growth, and schedule growth. Constrained by the data as collected by the Benchmarking and Metrics Database, Mitchell defined incentives as either positive or negative, or a combination of both. In contrast to this thesis, Mitchell excluded contractor

responses from his analysis based on a premise that owners ultimately decide on the inclusion of contract incentives.

The database included accumulated data collected over a two-year period from 1996 through 1997. The database consisted of 393 owner and contractor projects totaling over $20.6 billion in cost. Most of the projects were classified as "Heavy Industrial" and were located in the United States and Canada (CII BM&M Report 1997).

Based on Mitchell's analysis, the following recommendations were offered to any entity engaged in the procurement of construction related services:

- Utilize safety incentives to the maximum extent. The benefits to a lower LWCIR are significant. Positive safety incentives employed on projects containing over 250,000 craft-work-hours resulted in a drastic reduction in the average LWCIR;
- Avoid the use of "negative-only" schedule incentives, particularly liquidated damages clauses. These clauses immediately create an adversarial relationship between owners and contractors and are counterproductive to reducing the project duration. The projects employing "negative-only" schedule incentives experienced an average schedule growth almost four times that of those projects with no schedule incentives or positive/combined schedule incentives;
- If incentives are desired, utilize a "packaged" approach. By using 2 or more incentives, the chances are increased that the project will experience both reduced cost growth and reduced construction duration.
- If incentives are employed, the contractor must be given total control over their destiny. An incentive will not accomplish its

objective if the contractor is helpless in meeting the desired outcome.

- If the resources are not available to include monetary incentives in a contract, there are other ways of aligning objectives and rewarding desired behavior.
- Do not blindly include incentives in any contract. Owners should become educated on incentive use and realize that incentives should be designed to reward contractors for desired behavior, not to reward the assumption of additional risk.

2.6 CONTRACT INCENTIVES

The following literature review was completed in order to provide the author of this report with a strong foundation of knowledge on the purpose and use of construction contract incentives. Much of this review is consolidated from previous research as conducted by Jayson Mitchell (1998) on the "Impact of Incentives on Project Performance." The purpose of contract incentives will be discussed first, followed by a discussion on owner and contractor goals and objectives for construction projects. Subsequently, risk allocation will then be discussed. These topics are invaluable to the comprehension of incentive contracting.

Stukhart points out that contract incentives "are the means by which an owner intends to secure certain project goals through the contracting process" (Stukhart 1984). Put more simply, they encourage the contractor to adopt the owners project objectives, essentially making them mutual objectives. By doing so, both the owner and contractor will ideally maximize their respective benefits, assuming a proper incentive plan is developed. Since one of the main motivators for a contractor is often profit, money awards are the most frequently employed incentives.

Project goals can be quite diverse. The main goals that incentives support are reduced cost, reduced project duration (schedule), increased safety performance, and better quality. Both the owner and contractor usually adopt the aforementioned goals, albeit each usually occupying a different priority. Neil points out that owners are finding that incentives are a valuable tool in supporting other goals such as the improvement of day-to-day management of work, maintaining favorable labor relations, assuring commitment of the best personnel by the contractor, and improving owner/contractor communication and cooperation (Neil 1990). Admittedly, by effectively motivating a contractor to focus on goals such as reduced cost, reduced schedule growth, and reduced accidents, these "indirect" goals are likely to follow suit.

The Construction Industry Institute reported in 1995 that incentives improve performance in the following ways:

- They drive the definition of the project;
- They align project participants on common objectives;
- They create an interdependence among project participants;
- They establish a mutually supportive environment;
- They open communication channels and enhance team building;
- They reward desired behavior.

Again, by establishing incentives for project performance, the above goals are more likely to be realized.

As previously mentioned, the purpose of contract incentives is to bring the objectives of the contractor in line with those of the owner. These objectives need to be communicated effectively to the contractor if the desired results are to be realized. Unless the objectives are clearly understood by both parties, they will not be effective (Stukhart 1984). Generally speaking, the owner of a project will usually have three accepted goals: most

economical cost, specified quality, and on-time completion (Stukhart 1984). The contractor will typically maintain the obvious goal of maximizing their profit, while minimizing project risk.

Both owners and contractors must realize that risk is a principle that must be shared, and contractors must be able to control the resources necessary to achieve the incentives. Risk should be commensurate with potential gains (Stukhart 1984). Stukhart defines risk as the exposure to possible economic loss or gain. He further states that risk allocation is very important in order for incentives to be effective. Risk is allocated to contracting parties in order to motivate them to perform in a professional manner. It is based in part on the return of profit to be realized (Stukhart 1984). As previously mentioned, the degree of control over the risk must be considered. Responsibility for an end result must entail complete control over its occurrence. Finally, the relative "ability" of the parties to protect themselves against the risk is also a major consideration (Stukhart 1984).

Ibbs and Abu-Hijleh (1988) state that "excessive risk" offers no incentive value. They further state that it is in the owners best interest not to pass on all risks to the contractor, otherwise adversarial relationships will develop which counteract the goals of the incentive process. In summary, performance can be encouraged by the simple allocation of reasonable risk.

There are many types of incentives available to owners and contractors. Depending upon the desired outcome of a project, the proper incentive(s) can be selected. Positive incentives reward a contractor for desired results, whereas negative incentives attempt to dissuade poor performance in specific areas by decreasing the amount of a contractor's fee. Incentives can be based on cost, quality, safety, schedule, and other parameters (Mitchell 1998).

Most would agree that the best contractual incentive programs have a "win" feature. Those with only a "lose" potential are generally frowned upon

(Neil 1990). A "win" feature is essentially a positive incentive, and a "lose" feature a negative incentive. A positive incentive focuses on the desired outcome, and rewards this desired outcome in a positive way, usually in the form of a monetary award. Positive incentives encourage positive contractor actions, behaviors, and relationships, as opposed to negative incentives (liquidated damages, which assess a penalty for late completion, are considered a negative incentive) (Neil 1990). Ashley and Workman (1986) point out that research has demonstrated that positive incentives contribute to improved project results, while negative incentives generally hamper project performance.

A combination of positive and negative incentives may be the solution for owners who are a skeptical of a "positive" only approach. Combined incentives and cost sharing generally keep the contractor in good alignment with the customer's objectives and can be combined with schedule, safety, and output performance incentives to match and balance contractor incentives with customer objectives (CII Implementation Report 1995). This report further states that combined incentives, although difficult to administer, have proven fairly successful. Thus an educated, knowledgeable owner with the requisite resources could benefit from the use of combined incentives.

For all incentive plans to work, it is crucial that the criteria be identified and agreed upon well in advance. Negotiated targets result in greater ownership and commitment by the contractor (Ibbs and Abu-Hijleh 1988). In addition, a cooperative relationship between the parties is considered instrumental in reducing project uncertainty and increasing the chances for project success (CII 1993). Furthermore, owner personnel must genuinely want the contractor to achieve the maximum incentive because it corresponds to maximum owner success (CII 1996). Jaraiedi, Plummer, and Aber (1995) state that it is important for the contracting agency or owner to do everything possible to eliminate delays and disruptions. This essentially means that extra

time and effort must be given to project development so as to avoid costly changes once the project begins. These changes not only affect the cost, but may impact the completion of a milestone or the entire construction process. If changes are made, deadlines and targets should be adjusted so the contractor does not suffer a reduced award for circumstances that are the fault of the owner.

Even with all of the possible advantages of using incentives, there are some disadvantages as well. Positive incentives require substantially more contract administration. Ashley and Workman state that contracts with positive incentives appear to have stricter enforcement, greater disputes, and more suggested improvement than contracts without positive incentives (with the exception of positive cost incentives) (Ashley and Workman 1986). There is a tendency in this situation for owners to induce the contractor to accept more risk with incentives, which, as stated earlier, is not the purpose of incentives

These disadvantages can be overcome with the proper awareness and management. It is possible to derive the positive benefits from incentive use, and CII has provided the following lessons learned (Howard and Bell 1998):

- There is no single compensation strategy that is applicable to all projects any more than there is one set of needs that determine every owner's successes.
- The development of effective contractor compensation plans that lead to owner success is highly individualized to the specific project and to the personalities and philosophies of the project leaders that craft the contract.
- Incentives and monitoring are the "carrot and stick" solutions to the owner/contractor conflicts inherent to the capital project process.
- A high level of trust and communication between the owner and contractor is needed to develop effective compensation plans.

Recommendations include:

- Share owner business objectives with the contractor as openly as possible to enable innovative suggestions of project execution and compensation strategies.
- Develop general guidelines that can be used by project teams to develop incentive plans reflective of individual project needs.
- Jointly develop with owner and contractor the specifics of incentive plans. This creates a sense of ownership and commitment.
- Develop owners' sources of information relative to setting of performance targets, such as estimating expertise, benchmarking, or competition from the construction market, to ensure challenging, yet possible, incentive targets.
- Optimize owner project team structure, work processes, and decision making process to maximize the degree of control the contractor possesses over performance areas subject to incentives.
- Monitor the impact of the compensation plan during the project and adjust if required.
- Keep incentive plans as simple as possible. Teambuilding and other activities that create team pride and cohesiveness can provide a low cost incentive to cooperate toward a common goal.

In summary, much has been written on the use of contract incentives. However, much of the information is outdated and lacks application to current industry practices. Additionally, much of the data are based on subjective assessments and lack quantitative evaluation. This thesis will investigate

industry perceptions of contract incentives and frame the results within a quantitative analysis. Chapter 3 describes the research methodology used to complete this investigation.

Chapter 3: Research Methodology

The data used to analyze incentive usage in this thesis were obtained from the Construction Industry Institute (CII) by two different means. During the first phase, data were obtained through a series of surveys and structured interviews as drafted by the author in support of the CII Implementation Feedback Team 99-1. A listing of members of IFT 99-1 is provided in Appendix A. The second phase consisted of analyzing quantitative data from CII's Benchmarking and Metrics Version 3.0 Database. The flowchart as displayed in Figure 3.1 describes the information gathering, synthesis, and analysis.

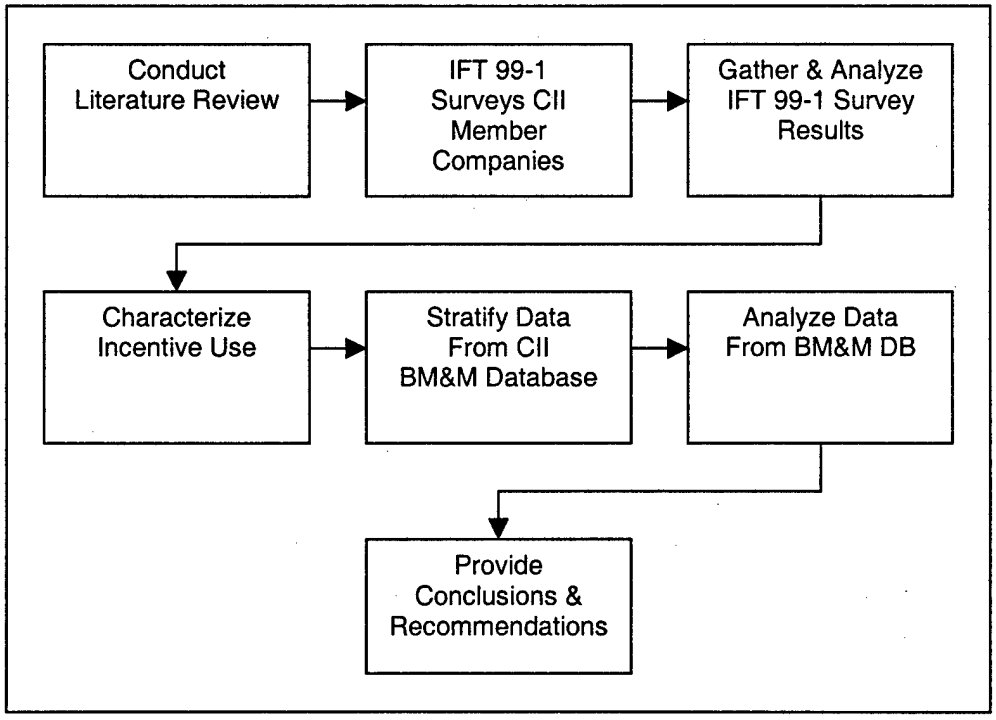

Figure 3.1 Research Methodology

3.1 LITERATURE REVIEW

Upon conducting the literature review, very few publications were found that specifically addressed the use of contract incentives as they impacted project performance parameters. CII identified this same industry shortcoming and formed Research Team 114 to further investigate various contract strategies. Thirty-two strategies were identified and subsequently reported on during the 1996 CII Annual Conference. To further characterize the use of specific incentives by member companies, CII formed Implementation Feedback Team 99-1.

In October 1998, IFT 99-1 reviewed the list of 32 Compensation Strategies from Research Report 114-11 and refined the list down to 22 specific incentives. The refinement process eliminated redundant strategies and those construed as ambiguous, or easily misinterpreted. This distillation method facilitated a more efficient survey process and more accurately reflected the actual incentives utilized by the member companies.

3.2 SURVEY INSTRUMENTS

All of the subjective data gathered to analyze incentive use was obtained from survey instruments as structured by the author and CII Implementation Feedback Team 99-1.

Initially, the team sent out a brief questionnaire to 83 member companies of the Construction Industry Institute. Of the 83 member companies surveyed, 37 acknowledged use of incentive compensation programs for contracting capital engineering, procurement and construction (EPC) projects. As the focus of IFT 99-1 was to elicit information from incentive users, a detailed survey was sent to the 37 companies who positively responded. Copies of the preliminary questionnaire and IFT 99-1 survey are given in Appendix B.

Of the 37 member companies surveyed with a follow-up questionnaire, only 25 provided detailed responses. Fourteen Owners and 11 Contractors were represented in these 25 organizations. Multiple surveys were received from several companies, which resulted in a total of 36 responses. The data were collected and analyzed, and subsequently provided the basis of this analysis.

The survey was structured in a manner to subjectively measure respondent assessments of incentive use on performance parameters of cost, quality, schedule, and safety. A scale (-3 to +3) was developed to rate the effectiveness and frequency of use for each of the 22 incentives investigated. A rating of zero meant that the incentive was neutral and provided no appreciable positive results, nor detrimental effects to the project. This rating system helped quantify the potential benefits and usefulness of the incentives and allowed for a common basis for comparison. Such quantification was regarded as a point of reference for member companies when considering whether to use innovative incentives on future projects as a compensation strategy. The source data used during analysis are presented in Appendix C.

3.3 BENCHMARKING & METRICS DATABASE

As stated earlier, the BM&M database includes three years of accumulated data. The files for each year are maintained separately, thus a significant amount of time was dedicated to stratifying the data from the 1996 files (Version 1.0), the 1997 files (Version 2.0), and the 1998 files (Version 3.0).

Prior to analyzing the BM&M database, a thorough review was performed and applicable questions selected from the CII BM&M Version 3.0 Questionnaire. The relevant CII survey questions that were selected are found in Appendix D.

In an effort to compare like-respondents to those described in Chapter 4, only data from the CII member companies responding to the use questionnaire were subjected to analysis. Furthermore, data were pulled from the master database file and stratified by construction phase only using functions defined as either Prime Contractor (PC), General Contractor (GC), Construction Manager (CM), or Project Manager (PM).

The BM&M incentive information referred to was simply each owner's or contractor's reply concerning the use of cost, quality, safety, and schedule incentives, as well as the type used (positive, negative, or both). Upon consolidating specific incentive information within each file, both versions of data were screened and all of the data unrelated to this research were deleted so as to provide for a more streamlined, easy to manipulate file. The source data for quantitative characterization of incentive use by CII member companies is consolidated in Appendix E. It includes the project number; construction function; the types of incentives used across the four performance parameters of cost, quality, safety and schedule; country; project type; and, project nature.

The spreadsheet and graphical display programs used for this entire process involved respective use of both Microsoft Access™ and Microsoft Excel™. Microsoft Access™ proved extremely helpful in performing numerous queries and sorting of data using a multitude of filters. Microsoft Excel™ was primarily used to perform mean calculations and graphically display all results.

The next chapter provides a summary of the research as conducted by the author on characterized incentive use by CII member companies. As previously mentioned, this analysis is solely based on subjective assessments of contract incentive usage and the respective impact on project performance parameters: cost, quality, safety, and schedule. Chapter 5 presents the quantitative findings as analyzed from CII's Benchmarking and Metrics Database.

Chapter 4: Characterization of Incentive Usage by CII Member Companies

In October 1998, the author joined CII's Implementation Feedback Team 99-1. As stated earlier, its purpose was to assist member organizations in realizing an increased competitive advantage by adopting a more effective and efficient capital project management process. As the only graduate research assistant on IFT 99-1, the author's responsibilities included the following activities:

- Prepared survey instrument to gather information from all CII member companies;
- Consolidated completed surveys and created a database for storage of information;
- Conducted detailed analysis of data, including: incentive usage by all companies; divergence of opinions between owners and contractors; composite and individual impact of incentives on project performance parameters (Cost, Quality, Safety, Schedule);
- Prepared presentation of results for the 1999 CII and CPI Annual Conferences;
- Conducted follow-up quantitative characterization of incentive usage by analyzing results obtained from the CII BM&M Database.

During analysis, the 32 Compensation Strategies from Research Report 114-11 were refined down to 22 specific incentives by IFT 99-1. The refinement process eliminated redundant strategies and those construed as ambiguous, or easily misinterpreted. This distillation method facilitated a more efficient survey process and more accurately reflected the incentives used by the member companies. The refined list of 22 incentives and brief descriptions of each are presented in Table 4.1.

Table 4.1 Contract Incentives

No.	Incentive	Description
1	End of Project Determination	The owner retains the right to adjust the contractor's fees based on end of project performance; can be further defined into subsets or categories; including retroactive assessment.
2	Team Incentive Plan	Incentive plan customized distribution to team members based on detailed "descriptions of success" to be achieved by the team members and overall project results.
3	Future Business Opportunity	Opportunity to bid/propose on future work based on successful completion of previous projects.
4	Benchmarking	Incentive targets based on benchmarking results with aggressive yet achievable targets developed from benchmarking database. May include sharing overruns and underruns with contractor.
5	Subcontractor Participation	Subcontractors participate in the incentives program.
6	Multiple Performance Criteria	Contractor incentive fee earned through multiple rather than single performance parameters.
7	Joint Engineer-Contractor Results	Based on joint engineer/contractor performance results rather than performance of one element. Promotes teamwork and cooperation.
8	Schedule	Based on multiple schedule milestones.
9	Plant Performance	Incentive fee based on operating performance of plant, including production, maintenance parameters, short term and long term criteria.
10	Schedule and Cost	Combines performance on both cost and schedule performance.
11	Fixed Overhead	Fixed fee for constructor's staff, home office, overhead and facilities.
12	Engineering Rework	Established criteria for contractor rework resulting from engineering errors.
13	All-Inclusive Engineering Rate	Hourly rate for engineering charges which covers/includes all specifically identified personnel plus other miscellaneous office overhead costs except travel.
14	Equity Risk Assumption	Contractor assumes portion of project with equity at risk.
15	Underrun Sharing	Contractor and owner share cost underrun on a pre-determined percentage.
16	Step Function Cost and Schedule	Incentive fee based on cost and schedule performance at rates within selected ranges; the rates differ between the established ranges.
17	Safety - - All or Nothing	Determined on safety results at the end of project; no intermediate evaluation.
18	Plant Downtime	Based on plant reliability after start-up compared with capacity.
19	Capital Budgeting Effectiveness	Based on minimum deviation from the time-based capital expenditure forecast.
20	Craft Productivity	Based on historical productivity rates with resulting labor cost savings shared between owner and contractor. Union craft employees may participate with established hourly bonus paid. Quality must be closely monitored.
21	Safety	Based on achieving performance targets at specified milestones.
22	Continuous Improvement	Based on "raising the bar" for performance standards at specified milestones.

The team then sent out a brief questionnaire to 83 member companies of the Construction Industry Institute. Of the 83 member companies surveyed, 43 responded. Thirty-seven out of 43 (86%) of the respondents acknowledged use of incentive compensation programs for contracting capital engineering, procurement and construction (EPC) projects. As the focus of IFT 99-1 was to elicit information from incentive users, a detailed survey was subsequently sent to the 37 companies that positively responded. The IFT 99-1 Preliminary Questionnaire and Survey are provided in Appendix B.

4.1 SURVEY DESCRIPTION

Of the 37 member companies surveyed with a follow-up questionnaire, only 25 provided detailed responses. Fourteen Owners and 11 Contractors represented these 25 organizations. Several companies provided multiple responses for a total of 36 surveys. The data from these 36 surveys were collected and analyzed, and subsequently provided the basis of the characterized incentive use research.

The survey was structured in a manner to objectively measure respondent assessments of incentive use on performance parameters of cost, quality, schedule, and safety. A scale (-3 to +3) was developed to rate the effectiveness and frequency of use for each of the 22 incentives investigated. A rating of +3 represented the most positive effect, whereas –3 represented the most adverse effect. A rating of 0 meant that the incentive was neutral and provided no appreciable positive results, nor detriment to the project. This rating system helped quantify the potential benefits and usefulness of the incentives and allowed for a common basis for comparison. Such quantification was regarded as a point of reference for member companies when considering whether to use innovative incentives on future projects as a compensation strategy.

4.2 DATABASE MANAGEMENT

With a significant amount of data to analyze, database construction became more important. Data were consolidated and analyzed through the use of MS Excel™.

After consolidating the 36 surveys and specifically reviewing the use of the 22 incentives, a percentage of use was calculated for each individual incentive. A sample calculation is provided in Table 4.2. The source data for characterization of incentive use by CII member companies is provided in Appendix C.

Table 4.2 Sample Calculation of Incentive Use (Percent)

Incentive	#1: End of Project Determination
Total Surveys	36
Total Positive Responses of Use	16
% of Use	(16/36)*(100) = 44.44%

All graphical displays were constructed through the use of the MS Excel™ chart wizard. Such displays were constructed using a building effect of horizontal bar charts, where each bar represented the degree of use for each incentive. The frequency of incentive use results are illustrated in Figure 4.1.

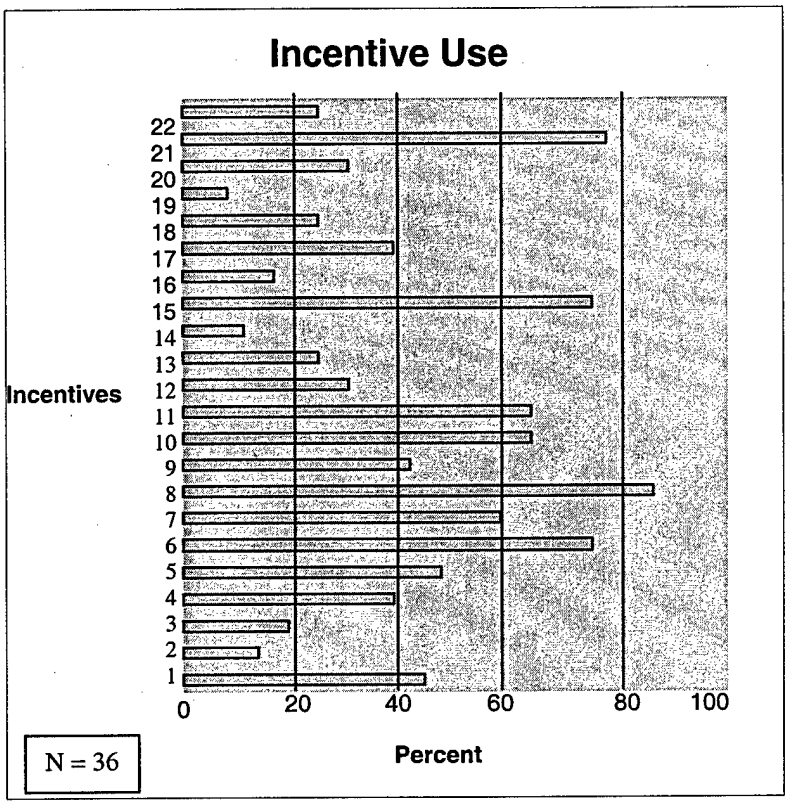

Figure 4.1 Frequency of Incentive Use by CII Member Companies

Each of the respondents was asked to assess the impact of each of the 22 incentives on individual performance parameters of cost, quality, safety, and schedule. As previously mentioned, a scale (-3 to +3) was developed to rate the effectiveness and frequency of use for each of the 22 incentives investigated. Mean values were calculated for each incentive as they applied to each parameter. A sample calculation is provided in Table 4.3 showing the effectiveness of "End of Project Determination" on quality. The "Total Score Assessed" was simply a summation of the responses of all participants. In this example, there were 17 respondents and the summation could range from –51 to +51.

Table 4.3 Sample Calculation of Mean-Value

Parameter Assessed:	Quality
Incentive	#1: End of Project Determination
Total Respondents	17 (of 36)
Total Companies Represented	13 (of 25)
Total Score Assessed	21 (of 51 Max.)
Mean-Value	21/17 = 1.24

Based on the above calculation, single parameters were compared based strictly on the mean values of each incentive. Additionally, a subsequent comparison was made based on the composite impact of incentives on all four parameters. This analysis was performed by comparing the summation of means for all four parameters for each incentive, respectively. Table 4.4 illustrates the composite calculation.

Table 4.4 Sample Calculation of Composite Impact

Incentive	#1: End of Project Determination
Cost Mean	2.00
Quality Mean	1.24
Safety Mean	1.76
Schedule Mean	1.88
Summation	6.88

The composite impact values for each incentive are provided in Appendix C and the subsequent results illustrated in Figure 4.2. As indicated below, the composite impact values were converted to a 100-point scale to

allow for a follow-on comparison with incentive use. These scaled values are also provided in Appendix C.

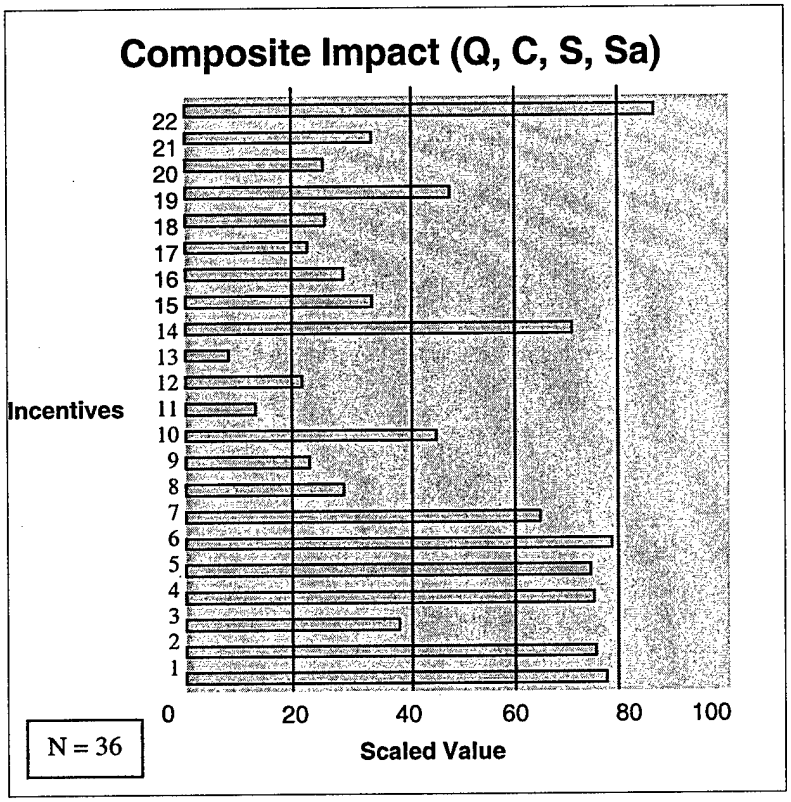

Figure 4.2 Composite Impact on Project Performance

Adopting a nominal scale and placing the graphical scales of Use and Impact side by side provided the foundation for a comparative analysis. Figure 4.3 displays this new comparison (Note that "Incentive Use" was graphically flipped for comparison purposes). This comparison provides the basis for further analyzing the overall impact of each incentive on composite parameters - using a quadrant evaluation.

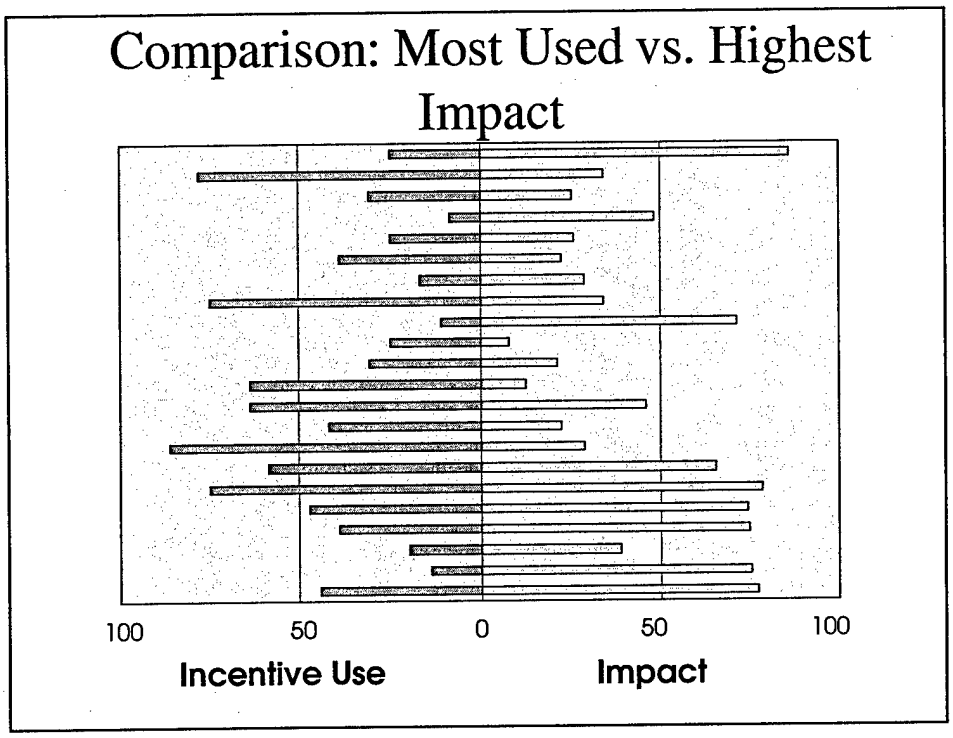

Figure 4.3 Direct Comparison of Incentive Use and Performance Impact

4.3 QUADRANT EVALUATION

The quadrant analysis provided an opportunity to display the graphical results of characterized incentive use in a different context. The quadrants also provide for ease of information exchange with regard to the most effective use of incentives.

From Figure 4.4, a degree of use can be derived and relative importance demonstrated by the 25 member companies. The quadrant evaluation stratified each incentive into one of four categories:

- A - High Use, High Impact
- B - Low Use, High Impact
- C - High Use, Low Impact
- D - Low Use, Low Impact

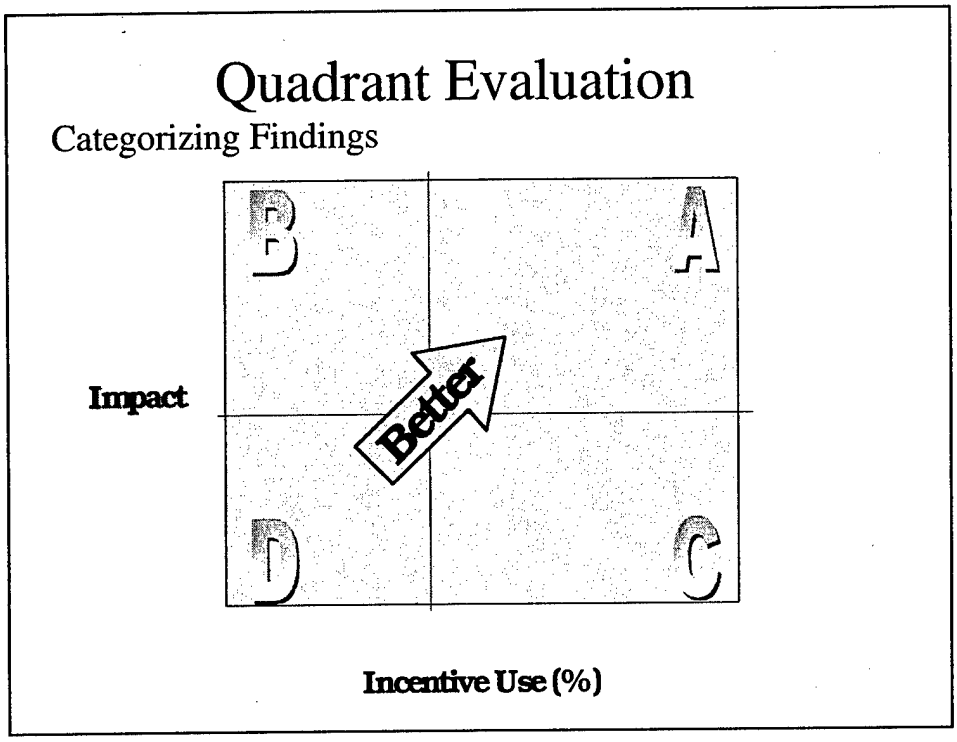

Figure 4.4 Categorizing Findings Using a Quadrant Evaluation

Each of the 22 incentives was converted into a datapoint using coordinates derived from the measured use (x-coordinate) and the composite impact on the four performance parameters (y-coordinate). Each of the datapoints was then plotted and overlaid with axes representative of mean values for each category. The quadrants were delineated by calculating the mean values for each intercept, 41.67 and 45.48 for use and composite impact values respectively. This tool, as displayed in Figure 4.5, provides the necessary measure of characterized incentive use and the resulting impact on project performance.

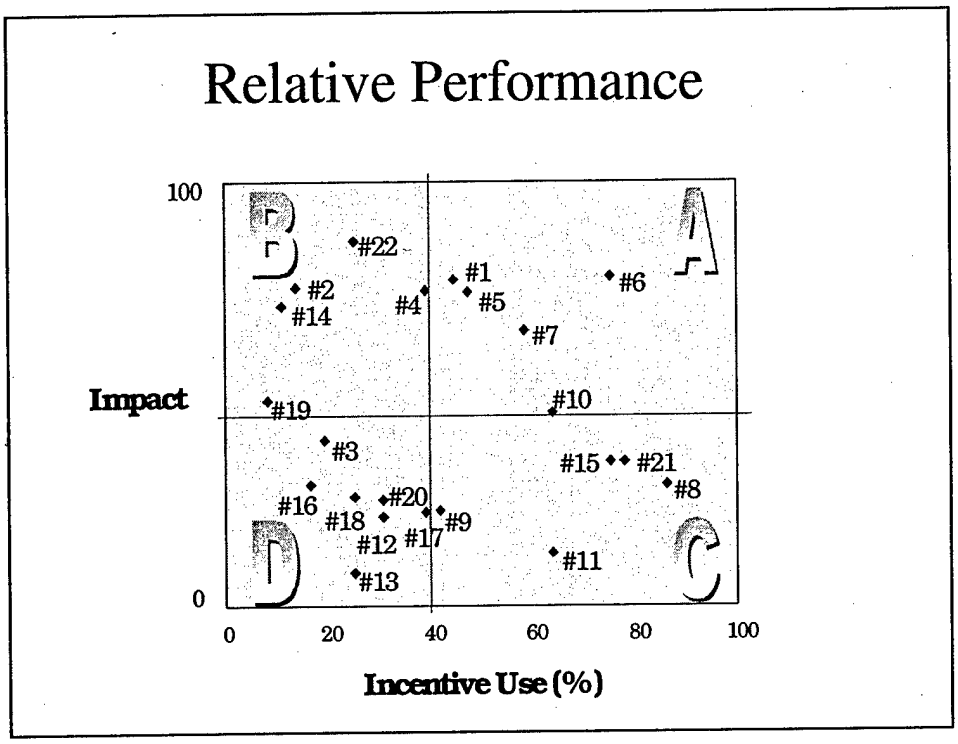

Figure 4.5 Impact of Incentive Use

After plotting each data point, the incentives were categorized by quadrant as illustrated in Figures 4.6 through 4.8. Without quantitative information available, the author speculated on various reasons for the resulting classifications.

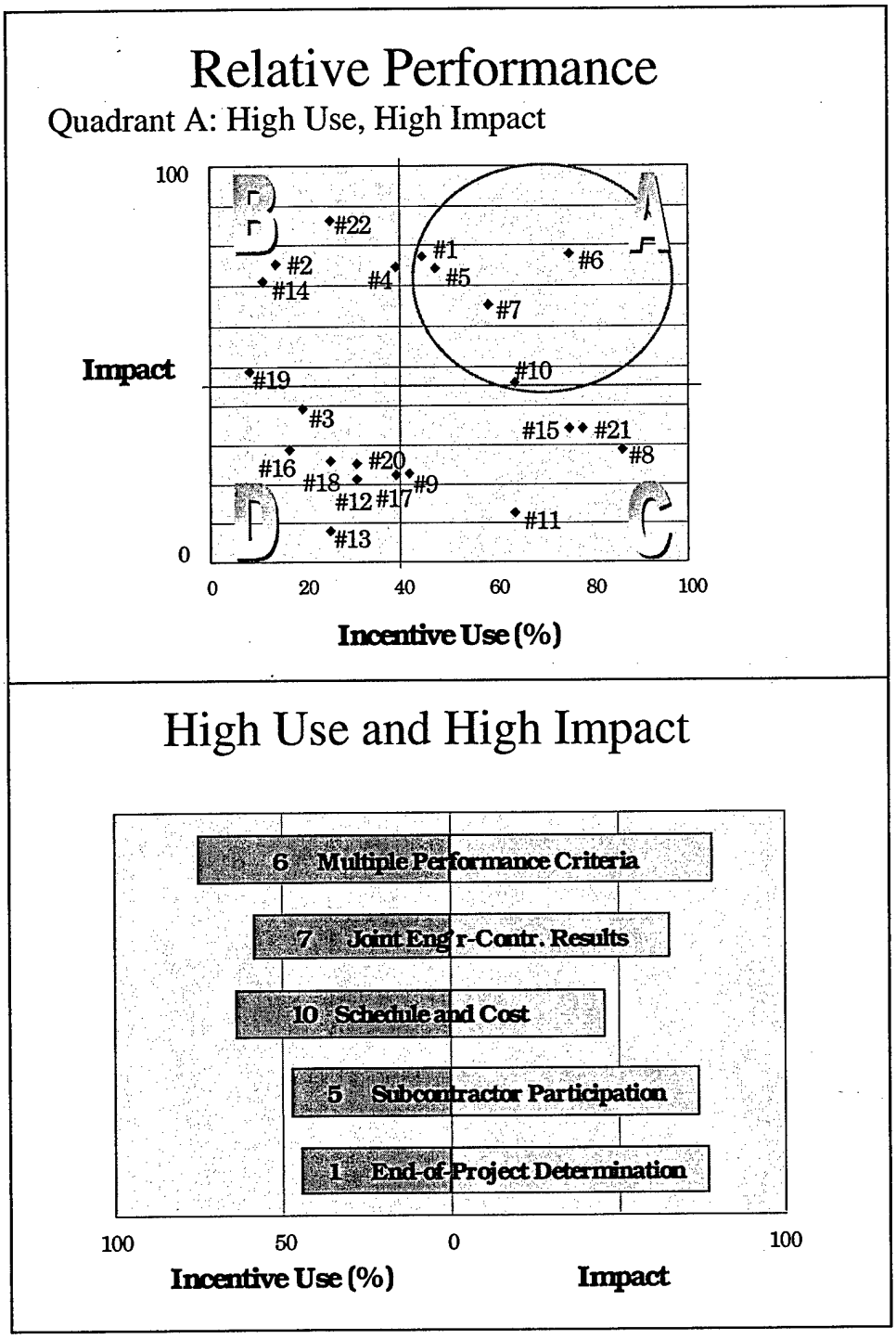

Figure 4.6 Quadrant A – Proven Performers

The incentives categorized as "High Use and High Impact" are defined in Table 4.5 below.

Table 4.5 High Use, High Impact Incentives

No.	Incentive	Description
1	End of Project Determination	The owner retains the right to adjust the contractor's fees based on end of project performance; can be further defined into subsets or categories; including retroactive assessment.
5	Subcontractor Participation	Subcontractors participate in the incentives program.
6	Multiple Performance Criteria	Contractor incentive fee earned through multiple rather than single performance parameters.
7	Joint Engineer-Contractor Results	Based on joint engineer/contractor performance results rather than performance of one element. Promotes teamwork and cooperation.
10	Schedule and Cost	Combines performance on both cost and schedule performance.

These incentives are widely used based on proven performance according to CII member companies. Emphasis is consistently placed on the promotion of teamwork, down to the subcontractor level. Multiple parameters are more sought after than single parameters often due to the complex nature of the construction industry. Joint engineer-contractor results may be an attempt to push EPC or design/build. Additionally, well-understood and proven use of cost and schedule controls continues to be thoroughly emphasized.

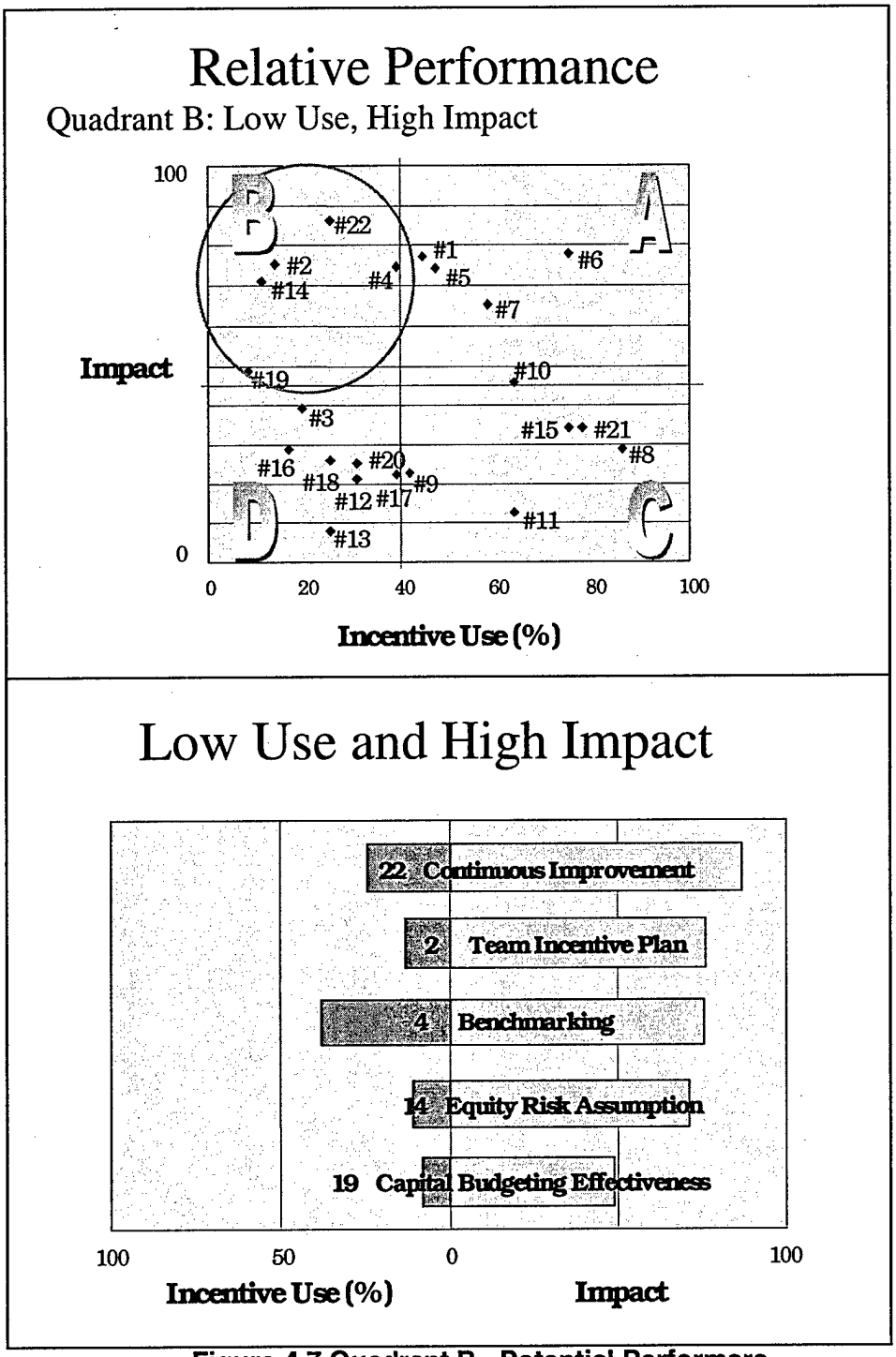

Figure 4.7 Quadrant B - Potential Performers

The incentives categorized as "Low Use and High Impact" are defined in Table 4.6 below.

Table 4.6 Low Use, High Impact Incentives

No.	Incentive	Description
2	Team Incentive Plan	Incentive plan customized distribution to team members based on detailed "descriptions of success" to be achieved by the team members and overall project results.
4	Benchmarking	Incentive targets based on benchmarking results with aggressive yet achievable targets developed from benchmarking database. May include sharing overruns and underruns with contractor.
14	Equity Risk Assumption	Contractor assumes portion of project with equity at risk.
19	Capital Budgeting Effectiveness	Based on minimum deviation from the time-based capital expenditure forecast.
22	Continuous Improvement	Based on "raising the bar" for performance standards at specified milestones.

These incentives are not widely used but tend to have increasingly positive impact across all four parameters. They are less recognized by CII member companies and less used; however, these incentives can best be described as having great potential. The construction industry is evolving with great emphasis being placed on teamwork, well-defined targets, risk-sharing, and continuous quality improvement. As the environment is also a competitive one, owners and contractors both realize the importance of effectively managing their capital expenditures. These incentives warrant further study to validate any correlation between increased use and greater (or lesser) impact on the performance parameters.

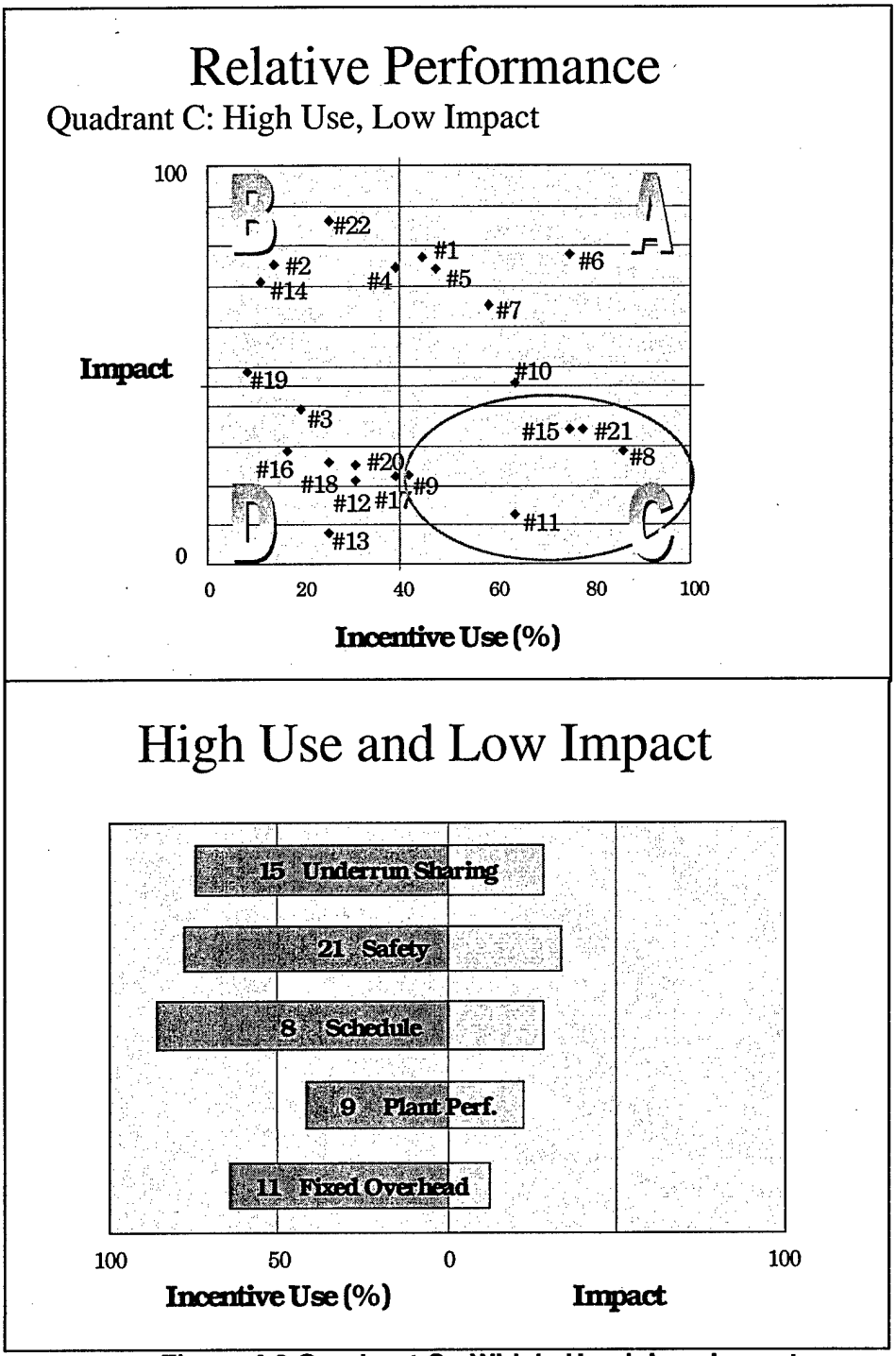

Figure 4.8 Quadrant C - Widely Used, Low Impact

The incentives categorized as "High Use and Low Impact" are defined in Table 4.7 below.

Table 4.7 High Use, Low Impact Incentives

No.	Incentive	Description
8	Schedule	Based on multiple schedule milestones.
9	Plant Performance	Incentive fee based on operating performance of plant, including production, maintenance parameters, short term and long term criteria.
11	Fixed Overhead	Fixed fee for constructor's staff, home office, overhead and facilities.
15	Underrun Sharing	Contractor and owner share cost underrun on a pre-determined percentage.
21	Safety	Based on achieving performance targets at specified milestones.

Regarding Quadrant C, schedules and subsequent updates prove critical in the successful completion of a project. However, incentives solely based on schedule have proven less than successful regardless of their wide use. Plant performance is likely used due to a lack of emphasis on start-up operations. The Fixed Overhead incentive is used by almost 70% of the companies surveyed with very little overall impact on project performance. This is likely due to its relatively small cost when compared to overall capital expenditure. With continuous emphasis on teamwork, cost underrun sharing between owner and contractor still has very little impact on overall project performance. Safety incentives are also widely used but also have seemingly less impact on overall project performance. Many professionals within the construction industry speculate that by placing increased emphasis on safety incentives, negative fallout will occur - including, but not limited to, inflated safety achievements and masking of otherwise reportable incidents.

Incentives classified in Quadrant D as "Low Use, Low Impact" were less scrutinized as compared to those found in Quadrants A, B, and C. However, it is important to recognize these as incentives to most likely avoid until further research can prove otherwise. The incentives are defined in Table 4.8.

Table 4.8 Low Use, Low Impact Incentives

No.	Incentive	Description
3	Future Business Opportunity	Opportunity to bid/propose on future work based on successful completion of previous projects.
12	Engineering Rework	Established criteria for contractor rework resulting from engineering errors.
13	All-Inclusive Engineering Rate	Hourly rate for engineering charges which covers/includes all specifically identified personnel plus other miscellaneous office overhead costs except travel.
16	Step Function Cost and Schedule	Incentive fee based on cost and schedule performance at rates within selected ranges; the rates differ between the established ranges.
17	Safety - - All or Nothing	Determined on safety results at the end of project; no intermediate evaluation.
18	Plant Downtime	Based on plant reliability after start-up compared with capacity.
20	Craft Productivity	Based on historical productivity rates with resulting labor cost savings shared between owner and contractor. Union craft employees may participate with established hourly bonus paid. Quality must be closely monitored.

There are many reasons why the incentives in Quadrant D may be underutilized, and subsequently reflect small impacts on project performance. The author, by speculation, attributes low use and low impact to:

- Lack of understanding, or incentive familiarization
- Complacency with existing operations, or status quo
- Outdated practices
- Complexity of contract administration
- Limited opportunities to apply

Though most of this investigation focused on the composite impact of incentives as characterized by CII member companies, several interesting observations were made when data were further segregated by owner and contractor responses and incentive impact on single parameters.

4.4 DIVERGING OPINIONS

When the 25 CII member companies were asked to subjectively assess the use of specific incentives and their relative impact on the four

performance parameters, data were stratified by both owner and contractor responses. Upon review of the data, it was found that three of the 25 incentives showed significant differences in opinion. Depending on the respondent (either owner or contractor), perception of impact on a specific performance parameter might be either positive or negative. Though the surveys did not provide any reasons for the diverging opinions, the author provides speculation prior to each of the illustrations as shown in Figures 4.9, 4.10, and 4.11.

As indicated in Figure 4.9, owners favored the use of the Plant Performance incentive. It is likely that owners incentivize plant performance based on their representation within the user group. In contrast, contractors believe that such an incentive has an overall negative impact on cost and schedule, probably due to overruns associated with start-up operations and unnecessary gold plating.

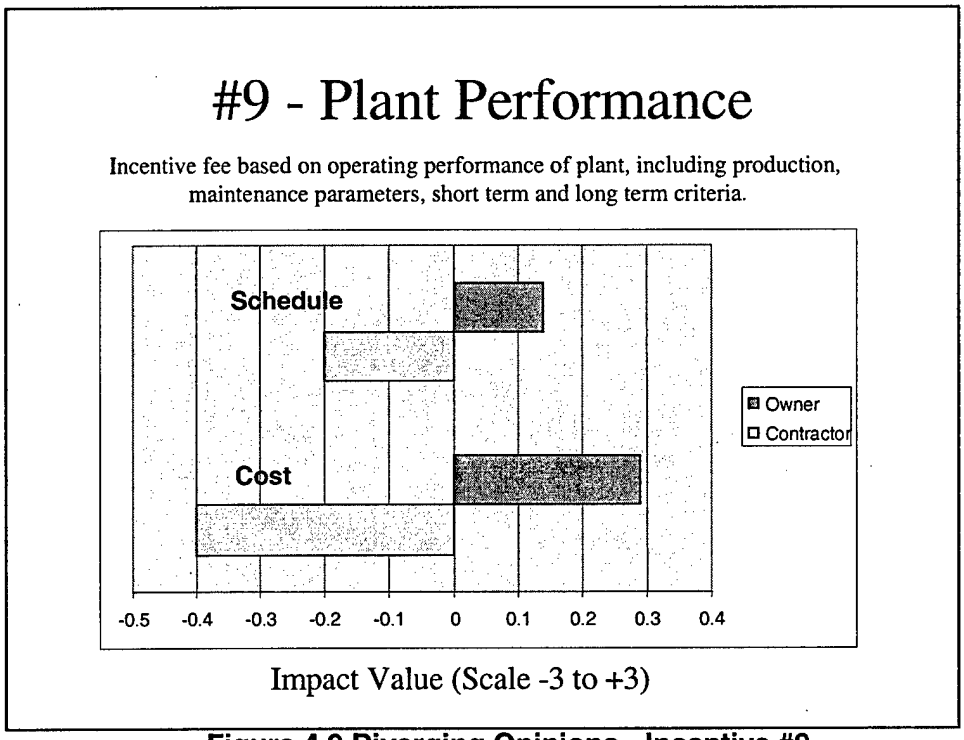

Figure 4.9 Diverging Opinions - Incentive #9

Referring to Figure 4.10, owners attribute an overall positive impact on all four parameters minus schedule. Undoubtedly, incentivizing Fixed Overhead will drive down costs and increase constraints on the contractor. Contractors perceive that Fixed Overhead incentives severely hinder quality, and to a lesser extent, the parameters of safety and cost. Fixed Cost incentives place contractors at greater risk and encourage shortcutting to shave costs, while simultaneously putting others in harm's way.

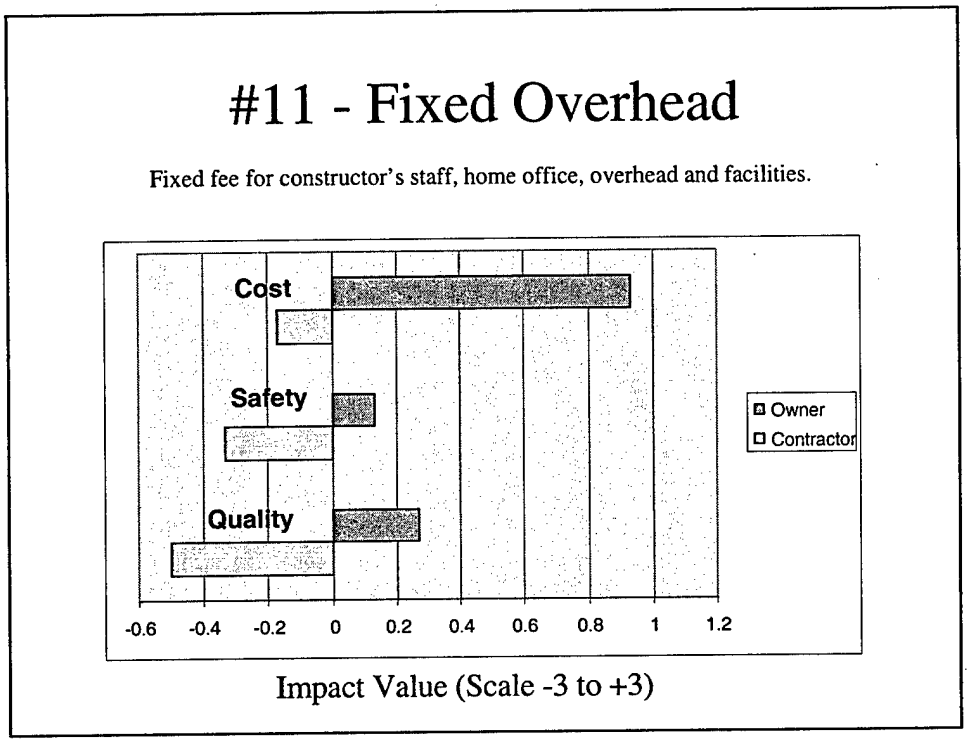

Figure 4.10 Diverging Opinions - Incentive #11

Whereas contractors perceived Plant Performance and Fixed Overhead as negative incentives, a positive perception is illustrated in Figure 4.11. Contractors favor incentivizing craft productivity. This incentive encourages teamwork down to the labor levels, yielding lower incident rates

and improving overall quality of construction services rendered. In contrast, owners believe that incentivizing craft productivity encourages fraudulent safety reporting and detracts from the quality of construction provided. Dislikes may include: increased complexity with contract administration; difficulty with establishing incentive targets down to the craft level; and, a shift of focus from project objectives to maximizing profit/benefits associated with the incentive plan.

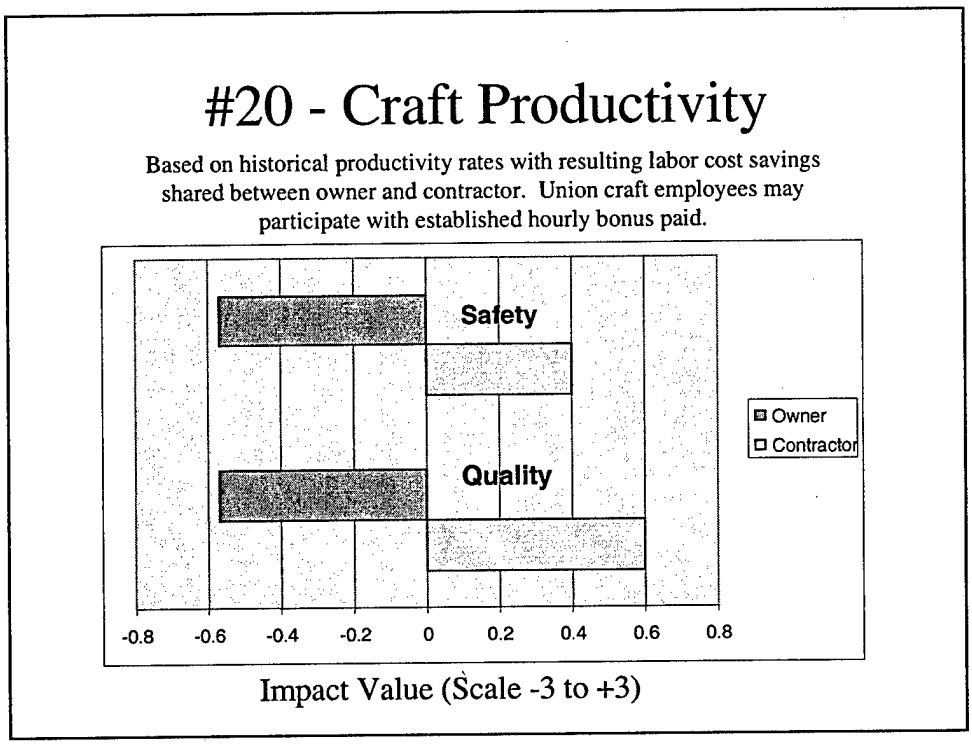

Figure 4.11 Diverging Opinions - Incentive #20

After identifying where diverging opinions exist between owners and contractors, the author focused on single-parameter incentives and the respective impact on project performance.

4.5 SINGLE PARAMETER ANALYSIS

A comparative analysis was performed using the composite impact values for all four parameters to those mean values calculated for each individual incentive impact on a specific parameter. The author then categorized each of the 22 incentives as either a multiple-parameter or a single-parameter incentive as shown in Table 4.9, and observed the corresponding prevalent use.

Table 4.9 Categorized Incentives

#	Incentive	Category	#	Incentive	Category
1	End of Project Determination	Q	12	Engineering Rework	Q
2	Team Incentive Plan	M	13	All-Inclusive Engineering Rate	C
3	Future Business Opportunity	M	14	Equity Risk Assumption	C
4	Benchmarking	M	15	Underrun Sharing	C
5	Subcontractor Participation	M	16	Step Function Cost and Schedule	M
6	Multiple Performance Criteria	M	17	Safety – All or Nothing	Sa
7	Joint Engineer-Contractor Results	M	18	Plant Downtime	Q
8	Schedule	S	19	Capital Budgeting Effectiveness	C
9	Plant Performance	Q	20	Craft Productivity	M
10	Schedule and Cost	M	21	Safety	Sa
11	Fixed Overhead	C	22	Continuous Improvement	Q

Note: Each of the 22 incentives was subjectively categorized by the author as either a multiple-parameter or single-parameter incentive. Abbreviations are defined below.

M – Multiple C – Cost Q – Quality Sa – Safety S - Schedule

Results indicated substantially different use of incentives by CII member companies when assessing impact on single-parameter incentives. More specifically, the investigation revealed effective use of like-incentives to impact that specific performance parameter. However, when compared to

multiple-parameter incentives, the author observed that single-parameter incentives have a diluted impact on all four parameters simultaneously.

This impact is illustrated in Figure 4.12. As illustrated in Quadrants A and B, multiple-parameter incentives exceed single-parameter incentives by 33% and thus indicate greater impact on project performance parameters.

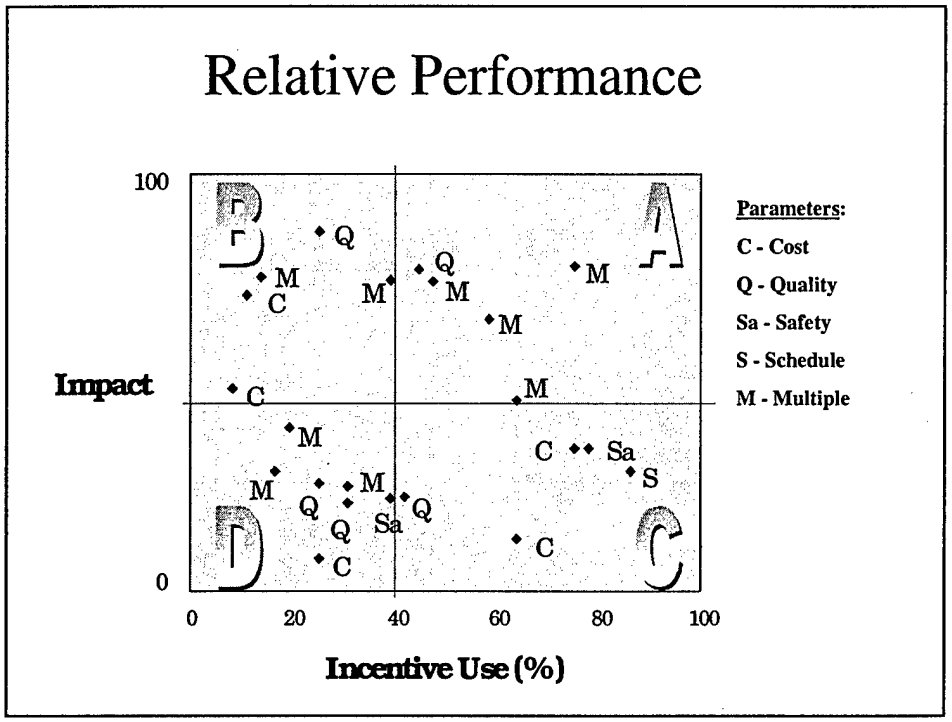

Figure 4.12 Multiple-Parameter vs. Single-Parameter Analysis (Subjective)

As there is much room for interpretation and speculation, a quantitative comparison was also performed using mean values and the results are illustrated in Table 4.10. The mean values were rank-ordered for each category and only the Top Five incentives were selected for comparison.

Table 4.10 Multiple-Parameter vs. Single-Parameter Comparison (Quantitative)

TOP FIVE INCENTIVES (Mean Values)					
Rank	**Multiple**	**Cost**	**Quality**	**Safety**	**Schedule**
1	**# 22 (Q)** Continuous Improvement	**#14 (C)** Equity Risk Assumption	**#22 (Q)** Continuous Improvement	**#2 (M)** Team Incentive Plan	**#8 (S)** Schedule
2	**#6 (M)** Multiple Performance Criteria	**#15 (C)** Underrun Sharing	**#2 (M)** Incentive Plan	**#21 (Sa)** Safety	**#5 (M)** Subcontractor Participation
3	**#1 (Q)** End-of-Project Determination	**#4 (M)** Bench-marking	**#9 (Q)** Plant Performance	**#17 (Sa)** Safety -- All or None	**#10 (M)** Schedule and Cost
4	**#2 (M)** Team Incentive Plan	**#16 (M)** Step Function Cost and Schedule	**#12 (Q)** Engineering Rework	**#22 (Q)** Continuous Improvement	**#6 (M)** Multiple Performance Criteria
5	**# 4 (M)** Benchmarking	**#10 (M)** Schedule and Cost	**#7 (M)** Joint Engineer-Contractor Results	**#1 (Q)** End-of-Project Determination	**#22 (Q)** Continuous Improvement

Several observations were made concerning the results as indicated above:

- Multiple-parameter incentives appear to have greater overall impact.
- Single-parameter incentives work well for that respective parameter.
- Single-parameter incentives have lower overall impact on all four-performance parameters.

As the purpose of Chapter 4 was to characterize the use of incentives by CII member companies, it is important to emphasize that the data analyzed was purely of a subjective nature - based on individual perceptions. The data were subjected to numerous analyses with emphasis on incentive use, performance impact, diverging opinions, and multiple/single-parameter comparisons. In an effort to quantitatively assess the characterized use of incentives, focus shifts to CII's Benchmarking and Metrics Database in Chapter 5.

Chapter 5: Quantitative Characterization of Incentives - Benchmarking and Metrics Database

The objective of the Benchmarking and Metrics characterization by CII member companies is to quantify the use of specific types of incentives based on frequency of use when applied to performance parameters of cost, quality, safety, and schedule. In contrast to the specific incentives described in Chapter 4, the Benchmarking and Metrics Questionnaire (Version 3.0) solicited information about the use of positive incentives, negative incentives, or a combination of both. The relevant questions used in the analysis are provided in Appendix D.

5.1 THE CII BENCHMARKING AND METRICS DATABASE

Prior to data analysis, the BM&M Questionnaire was screened for applicable project information. Table 5.1 provides a list of the questions selected to gather project information from the three questionnaires collectively - Versions 1.0, 2.0, and 3.0.

Table 5.1 CII Benchmarking and Metrics Questionnaire: Project Information

1,2	Company and Project Identification
3	Location of Project (Country)
7	Type of Project (e.g. Infrastructure, Heavy Industrial, Building)
8	Nature of Project (e.g. Addition, Grass Roots, Modernization)
10	Project Participants/Functions Performed
10	Incentives Used in Contract (e.g. Positive, Negative, Both)

Respondents to the three questionnaires consisted of 9 owner and 7 contractor companies who submitted a combined total of 61 projects as illustrated in Figure 5.1. Both owner and contractor companies submitted

multiple responses for a total of 97 contracts with affirmative incentive use. Data were stratified by the total number of contracts and projects as indicated below.

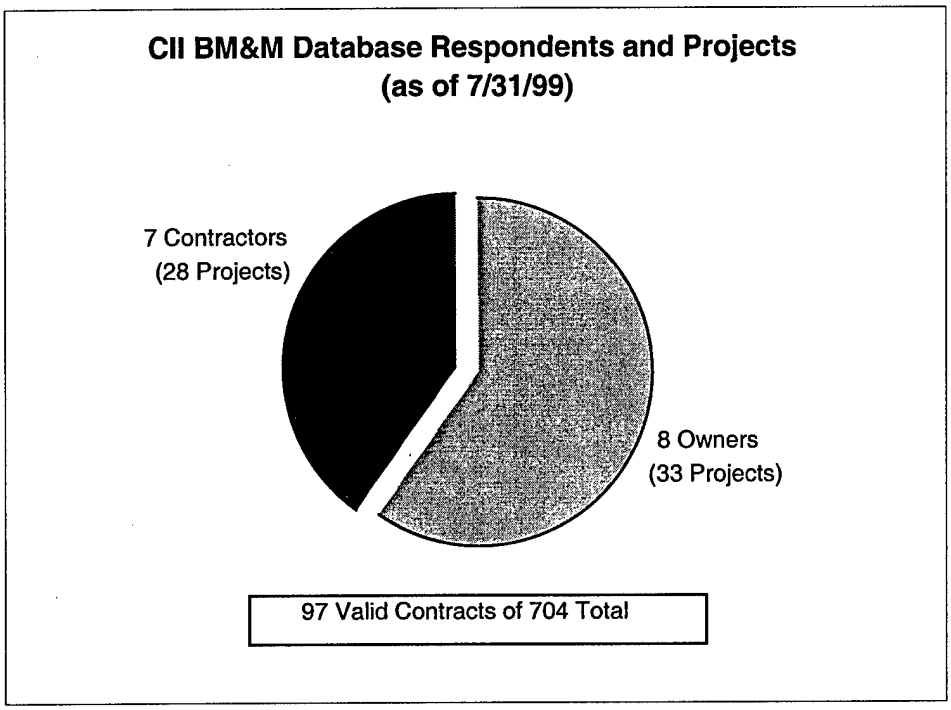

Figure 5.1 CII BM&M Database Respondents and Projects

These projects were categorized by industry sector, type, and project nature. The database identifies each one as falling within one of four industry types: Heavy Industrial, Light Industrial, Buildings, and Infrastructure. They are further broken down into 30 different project types including chemical manufacturing, metals refining and processing, oil refining, foods, and pharmaceuticals manufacturing. Each of these projects is additionally classified by project nature as grass roots, additions, or modernization projects. For purposes of clarification, definitions are provided in the CII BM&M Questionnaire in Appendix D. The source data for quantitative

characterization of incentive use by CII member companies is compiled in Appendix E.

5.2 DEVELOPMENT OF THE DATA SAMPLE

The sample for this analysis consists of 97 contract responses, representing 61 distinct projects. Of the 704 total respondents in the CII Benchmarking and Metrics Database (Version 3.0), 607 were eliminated based on the criteria listed in Table 5.2.

Table 5.2 Respondent Selection Criteria

	Screening Criteria	Impact
1	Utilization of CII member companies as surveyed by IFT 99-1 (Chapter 4)	Reduced sample from 704 to 594
2	Selective analysis of the following company functions: GC, PC, PM, and CM only.	Reduced sample from 594 to 288
3	Elimination of all responses with zero use of incentives.	Reduced sample from 288 to 97

After using the first two criteria in Table 5.2 to filter the sample population in the CII BM&M Database, 288 contract responses remained. After further filtering with the third criteria, only 97 of 288 (34%) contract responses indicated incentive use. This is in direct contrast to the perceived use of incentives by 37 of 43 (86%) CII member companies in Chapter 4. The resulting observation indicates that perception of incentive use is largely inflated compared to the quantitative characterization provided by the CII BM&M Database. Upon completion of the filtering process, the data were further characterized by industry sector, project type, and project nature.

Figure 5.2 illustrates how skewed the data sample is towards the heavy industrial sector.

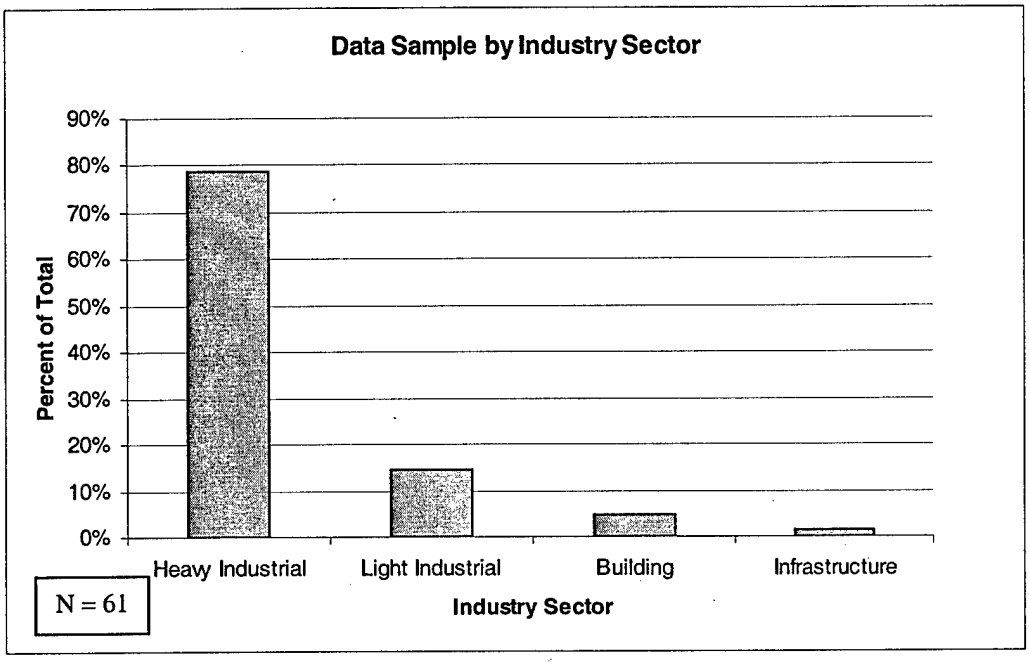

Figure 5.2 Data Sample by Industry Sector

Within each sector the data sample is further characterized by project type as illustrated in Table 5.3.

Table 5.3 Data Sample by Project Types within Industry Sector

Heavy Industrial	
Chemical Mfg.	17
Environmental	3
Metals Refining and Processing	10
Natural Gas Processing	1
Oil Exploration/Production	1
Oil Refining	11
Pulp and Paper	5
Total	48
Light Industrial	
Consumer Products Mfg.	2
Foods	4
Pharmaceuticals Mfg.	3
Total	9
Buildings	
Laboratory	1
Low-rise Office	1
Retail Building	1
Total	3
Infrastructure	
Water/Wastewater	1
Total	1
TOTAL	**61**

The data sample additionally exhibits a preponderance of projects that can be categorized under the project nature of "Additions." Figure 5.3 demonstrates the distribution consisting of 31 additions, 17 grass roots, and 13 modernization projects. The dominant presence of addition projects exceeds over 50 percent of the data sample.

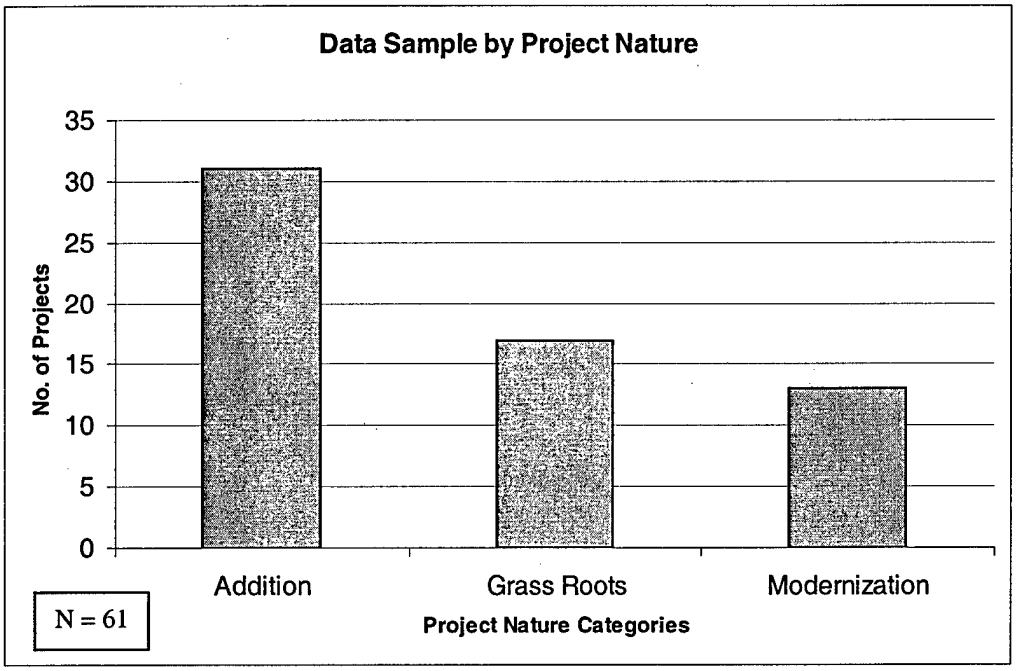

Figure 5.3 Data Sample by Project Nature

5.3 DATA ANALYSIS

Once the sample of projects was gathered and tabulated, the data were manipulated for two phases of analysis. First, a quantitative characterization of incentive use was calculated for each performance parameter. The results are illustrated in Figure 5.4. Several observations were made concerning incentive usage as applicable to each performance parameter and they are summarized below.

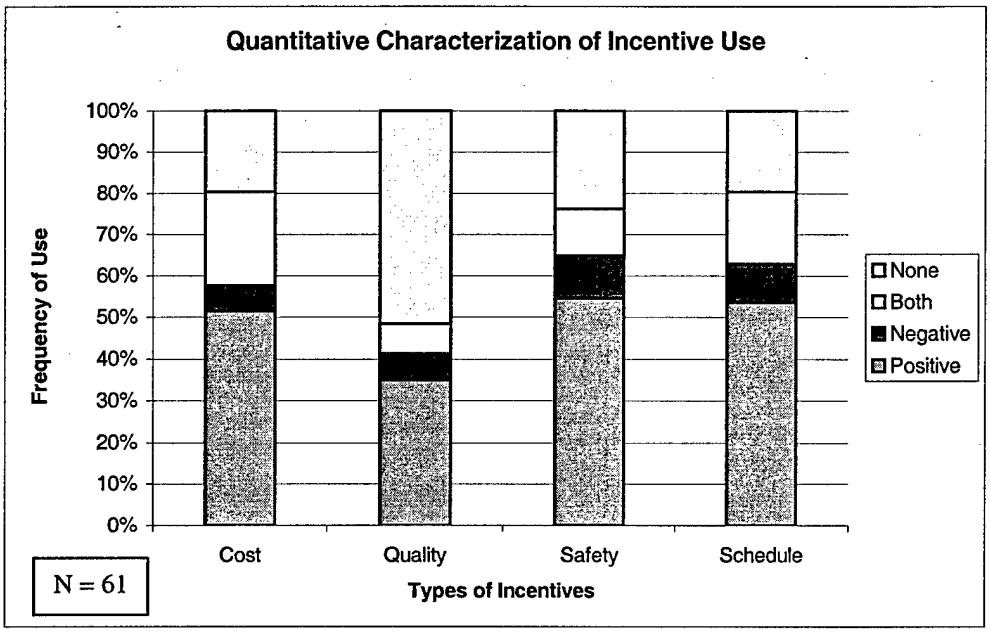

Figure 5.4 Quantitative Characterization of Incentive Use

Observations:

1. Positive incentives are used more than negative incentives across all four performance parameters with exception to quality.
2. Negative incentives are more widely used in conjunction with safety than the remaining parameters.
3. Safety is by far the most incentivized performance parameter when using either positive or negative incentives.
4. Combinations of positive and negative incentives are more applicable to cost first, then schedule. Combined incentives and cost sharing may keep the contractor in good alignment with the customer's objectives.
5. More than half of the companies surveyed do not incentivize the quality parameter. This may result from the unclear definition of quality and a lack of understanding on how best to quantify results.

The second phase of analysis consisted of categorizing each of the 22 IFT 99-1 incentives by type as defined in the BM&M database (positive, negative, or both). Based on the author's definitions, none of the incentives were categorized as negative only. The results are summarized in Table 5.4.

Table 5.4 Incentives Categorized by Type

#	Incentive	Category	#	Incentive	Category
1	End of Project Determination	B	12	Engineering Rework	+
2	Team Incentive Plan	+	13	All-Inclusive Engineering Rate	+
3	Future Business Opportunity	+	14	Equity Risk Assumption	B
4	Benchmarking	B	15	Underrun Sharing	+
5	Subcontractor Participation	+	16	Step Function Cost and Schedule	B
6	Multiple Performance Criteria	B	17	Safety – All or Nothing	B
7	Joint Engineer-Contractor Results	B	18	Plant Downtime	B
8	Schedule	B	19	Capital Budgeting Effectiveness	B
9	Plant Performance	B	20	Craft Productivity	B
10	Schedule and Cost	B	21	Safety	B
11	Fixed Overhead	B	22	Continuous Improvement	B

Note: Each of the 22 incentives was subjectively categorized by the author, by incentive type – positive, negative, or both. Abbreviations are defined below.

+ Positive Only - Negative Only B - Both

Using the same quadrant evaluation (from Chapter 4), incentives were re-plotted by incentive category as illustrated in Figure 5.5. A comparative analysis was then made between the BM&M data and that of the subjective assessment performed by the CII member companies as in Chapter 4. The goal of the analysis was to identify a pattern of incentive use. Observations and speculative comments are summarized below.

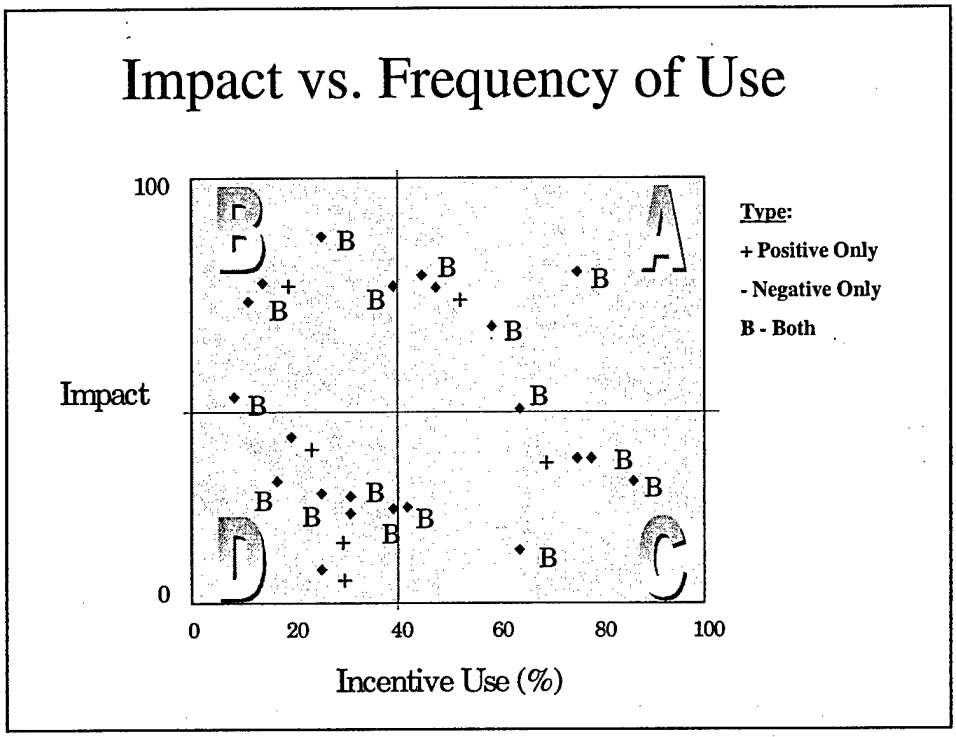

Figure 5.5 Impact of Incentive Use by Category

Observations:

1. The author categorized 16 of 22 (83%) incentives as characteristic of both positive and negative incentives.
2. Predominant use of positive only incentives are found in Quadrant D - Low Use, Low Impact. Though not yet proven, these incentives warrant further study to validate (or negate) such low overall impact on the performance parameters.
3. Use of multiple incentives (both positive and negative) exceeds use of single-type (either positive, or negative) incentives as categorized.
4. Eight of 10 (80%) of the incentives above the "Impact" delineation line are categorized as both, or a combination of positive and

negative incentives. This observation reinforces that a packaged approach, or multiple use of incentives, has a greater impact on project performance.

5. There is no identifiable pattern that correlates the subjective data described in Chapter 4 to that of the data obtained from the BM&M database.

Due to the speculative nature of the author's categorization, it is unlikely that a statistical analysis would prove any correlation between the two data sets. Each of the 22 incentives was broadly defined and is subject to vastly different interpretations. Additionally, small sample populations are not likely to produce statistically significant findings.

5.4 ANALYSIS SUMMARY

Of the 25 CII companies surveyed by the author and IFT 99-1, only 15 completed the BM&M Questionnaire. However, the respondents submitted a combined total of 61 projects for the analysis. The significant findings are reinforced with author speculation as presented below:

- Perception of incentive use is largely inflated by CII member companies compared to the quantitative characterization provided by the CII BM&M Database.
- There are few incentives employed that emphasize the importance of quality as a performance parameter due to poor definition and inadequate measurement practices.
- Positive incentives are used more than negative incentives across all four performance parameters with exception to quality.
- Negative incentives are more widely used in conjunction with safety than the remaining parameters.

- Safety is by far the most incentivized performance parameter when using either positive or negative incentives.
- Cost performance is more heavily incentivized using a combination of both positive and negative incentives, with schedule in second.
- The database is heavily skewed toward the heavy industrial sector and largely misrepresents the U.S. construction industry.

The objective of this chapter was to analyze quantitative data obtained from the CII Benchmarking and Metrics Database. More specifically, the degree with which positive, negative, and both types of incentives was measured to assess the impact on the four performance parameters. In contrast to the subjective assessment of specific incentives described in Chapter 4, the Benchmarking and Metrics Database provided the foundation for a quantitative look at characterized incentive use.

Chapter 6: Conclusions and Recommendations

6.1 CONCLUSIONS

This research investigation has sought to accomplish three objectives. The first objective was to characterize the use of incentives by CII member companies and assess their impact on the four performance parameters of cost, quality, safety, and schedule. The second objective was to provide a quantitative characterization using information from the CII Benchmarking and Metrics Database. The third was to provide a foundation from which to continue research of innovative construction contract incentives.

The author believes the first two objectives were accomplished as discussed in Chapters 4 and 5. The latter objective will be fulfilled through the subsequent discussion. General conclusions based on the findings concerning the characterized use of incentives by CII member organizations and the Benchmarking and Metrics Database are presented below.

6.1.1 CII Member Survey

- Incentive programs using multiple innovative incentives are being utilized frequently with substantial perceived positive impact for both Owners and Contractors.
- Contract incentives most widely used by CII member companies are indicated in Table 6.1:

Table 6.1 Most Widely Used Incentives by CII Member Companies (in rank order) Source: IFT 99-1

No.	Incentive	Description
8	Schedule	Based on multiple schedule milestones.
21	Safety	Based on achieving performance targets at specified milestones.
15	Underrun Sharing	Contractor and owner share cost underrun on a pre-determined percentage.
6	Multiple Performance Criteria	Contractor incentive fee earned through multiple rather than single performance parameters.
10	Schedule and Cost	Combines performance on both cost and schedule performance.
11	Fixed Overhead	Fixed fee for constructor's staff, home office, overhead and facilities.

- Incentives with the most positive impact on the four project performance parameters of cost, quality, safety, and schedule are indicated in Table 6.2:

Table 6.2 Top Six Incentives Based on Performance Impact (in rank order) Source: IFT 99-1

No.	Incentive	Description
22	Continuous Improvement	Based on "raising the bar" for performance standards at specified milestones.
6	Multiple Performance Criteria	Contractor incentive fee earned through multiple rather than single performance parameters.
1	End of Project Determination	The owner retains the right to adjust the contractor's fees based on end of project performance; can be further defined into subsets or categories; including retroactive assessment.
2	Team Incentive Plan	Incentive plan customized distribution to team members based on detailed "descriptions of success" to be achieved by the team members and overall project results.
4	Benchmarking	Incentive targets based on benchmarking results with aggressive yet achievable targets developed from benchmarking database. May include sharing overruns and underruns with contractor.
5	Subcontractor Participation	Subcontractors participate in the incentives program.

- Diverging opinions between owners and contractors were observed on the three incentives consolidated in Table 6.3 below:

Table 6.3 Diverging Opinions

Respondent	Incentives					
	#9 - Plant Performance		#11 - Fixed Overhead		#20 - Craft Productivity	
	+/- Impact	Parameter	+/- Impact	Parameter	+/- Impact	Parameter
Owner	+	C, S	+	C, Q, Sa	-	Q, Sa
Contractor	-	C, S	-	C, Q, Sa	+	Q, Sa

Note: The abbreviation for each parameter is defined below.

C = Cost Q = Quality Sa = Safety S = Schedule

- Each one of the parameters (cost, quality, safety, and schedule) yielded better results when incentivized individually, rather than when grouped as part of a multiple incentive program.
- If a single parameter is sought, but multi-parameters are employed, a dilution of the intended results and a lessening of the impact on the single preferred parameter will likely occur.
- Conflict between owners' and contractors' objectives is natural and should be acknowledged during joint development of the incentive plan.

6.1.2 BENCHMARKING AND METRICS DATABASE

Of the 25 CII companies surveyed by the author and IFT 99-1, only 15 completed the BM&M Questionnaire. However, the respondents submitted a

combined total of 61 projects for the analysis. The significant findings are reinforced with author speculation as presented below:

- Perception of incentive use is largely inflated by CII member companies compared to the quantitative characterization provided by the CII BM&M Database.
- There are few incentives employed that emphasize the importance of quality as a performance parameter. This may result from the unclear definition of quality and a lack of understanding on how best to quantify results.
- Positive incentives are used more than negative incentives across all four performance parameters with exception to quality.
- Negative incentives are more widely used in conjunction with safety than the remaining parameters.
- Safety is by far the most incentivized performance parameter when using either positive or negative incentives. RIR and LWCIR continue to provide accurate means with which to quantify safety performance on the jobsite.
- Cost performance is more heavily incentivized using a combination of both positive and negative incentives, with schedule in second. Combined incentives and cost sharing may keep the contractor in good alignment with the customer's objectives.
- The database is heavily skewed toward the heavy industrial sector. Both the data sample and the database are not, therefore, statistically representative of the U.S. Construction Industry as a whole.

6.2 RECOMMENDATIONS

This research investigation has, like many others, generated a list of recommendations that will hopefully improve future research efforts. Three sets of recommendations follow. The first is a compilation of suggestions as determined by the author and Implementation Feedback Team 99-1. The second list of recommendations addresses possible improvements to the Benchmarking and Metrics Database. The third list of recommendations addresses possible future research topics that build on the analysis and findings as presented by this thesis.

6.2.1 CII Member Survey

The author consolidated the following recommendations from the research results as provided by the subjective assessments by CII member companies and from other members of IFT 99-1.

- When employing multiple incentives, the magnitude of the impact one incentive may have on others must be seriously examined.
- It is important to tailor the incentives to the particular project and know when and under what circumstances particular incentives will make the project a success for both the Owner(s) and the Contractor(s).
- Regarding single parameter incentives, there is a need to consider utilizing single parameter incentives when a particular parameter or goal is paramount over the other parameters.
- There is a need to avoid implementing multi-faceted incentive programs that involve complex implementation procedures and evaluations - use straight forward, clear, unambiguous evaluation criteria which should not require a great deal of time and effort to implement.

- Organizations not currently using incentives should seriously consider the incentives identified in Quadrants A and B based on proven performance and great potential.
- It is very important to recognize that each of the 22 incentives examined were successfully employed by CII member organizations and all should be considered when selecting types of incentives for individual projects.

6.2.2 IMPROVING THE BM&M DATABASE

In an effort to improve upon an extremely valuable tool available to the construction industry, the following recommendations are provided for the CII Benchmarking and Metrics Committee. The recommendations are focused on improving the statistical representation of the U.S. Construction Industry and improving the current survey instrument with regard to incentive research.

- Add more projects from each industry sector to more accurately model the construction industry as a whole.
- Restructure the format of Question #10 (see Appendix D) to address the use of specific incentives, rather than generalized types described as positive, negative, or both. Multiple, in contrast to single, use of incentives can also be surveyed.
- Expand Question #10 to integrate performance data directly correlated with incentive usage (e.g. cost and schedule growth).
- Integrate use of CII research teams to augment the BM&M database whenever possible. Additionally, research teams should design questionnaires/surveys to complement data stored in the BM&M database.

6.2.3 FUTURE RESEARCH

Improvements can be made to the research methodology and the method and accuracy with which the findings were presented by focusing resources in the following areas:

- Isolate each of the incentives by quadrants identified in Chapter 4 and investigate reasons for proven success or failure.
- Hone in on the diverging opinions held by owners and contractors on the use of specific incentives as related to the four performance parameters.
- Improve IFT 99-1 Survey (Appendix B) to include quantitative performance parameters (e.g. cost and schedule growth, safety rates) and correlate to specific incentive use.
- Define methods to measure the performance parameter of quality and integrate into future CII research team surveys.

Appendix A

CII IFT 99-1 MEMBERS

Team Member	Title/Company	Location
David Herrington	Chevron Project Resources Company	Oakland, CA
John Lartin	Manager Contracts, Day & Zimmermann Inc.	Philadelphia, PA
Ken Lunsford	Phillips Petroleum Company	Bartlesville, OK
Tim Pederson	Vice President, Murphy Company	St. Louis, MO
Stephen Reuwer	General Manager, Florida Power & Light Energy, Inc.	North Palm Beach, FL
James Ross	Quality and Operations Services Manager, Kvaerner Songer	Pittsburgh, PA

Appendix B

CII IFT 99-1 PRELIMINARY QUESTIONNAIRE

CII IFT 99-1 SURVEY

CII IFT 99-1 PRELIMINARY QUESTIONNAIRE

From: _____
Name

_____
Organization

_____ _____ _____
Phone Fax Email Address

Incentive Contractor Compensation Implementation Feedback Questionnaire

1. CII Member Category: Owner Contractor

2. Does your organization use incentive compensation programs for contracting capital engineering, procurement and construction (EPC) projects?

   Yes Go to #3
   No Go to #4

3. If your response to #2 was "yes", please provide the names and contact information for people in your organization who have comprehensive knowledge of the use of incentive programs in capital projects.

   Name:_____
   Position:_____
   Telephone:_____ Fax:_____
   Email:_____

   (Please feel free to provide information for additional individuals)

4. If your response to #2 was "No", please indicate the reason your organization elected that alternative.

   a. Do not find incentive programs for contractors are effective.
      Please explain briefly:

   _____

   _____

   _____

   b. Contrary to organization's policy.
      Please explain briefly:

   _____

   _____

   _____

   c. We have had unsatisfactory results from the application of an incentive program.
      Please explain briefly:

   _____

   _____

   _____

   d. Other
      Please explain briefly:

   _____

   _____

Thank you for your support for this report on the implementation of Incentive Contractor Compensation!

CII Implementation Feedback Team 99-1
Innovative Contractor Compensation
Questionnaire

Owner ☐
Contractor ☐

Name:_____ Date: _____
Company:_____ Phone: _____
Fax: _____
Position/Title: _____ E-Mail: _____

Business Address: _____
_____
_____

All information provided will be handled in accordance with CII Confidentiality rules. All data will be merged such that the information can not be related to one member's organization. The source of specific information will not be released without authorization.

Questions.

1. Do you use any of the incentives as listed below? Yes☐ Go to 1A
   No ☐ Go to 1B

- ☐ (1) End of project determination of contractor fee
- ☐ (2) Incentive plan customized distribution to individual team members
- ☐ (3) Opportunity to bid future work to successful early bidders
- ☐ (4) Incentive targets based on benchmarking
- ☐ (5) Subcontractor participation in incentives
- ☐ (6) Contractor fee earned through multiple rather than single performance areas
- ☐ (7) Incentives based on joint engineer/contractor results
- ☐ (8) Schedule incentive
- ☐ (9) Plant performance incentive
- ☐ (10)On-time scheduled completion bonus coupled w/cost underrun share

- ☐ (11)Fixed fee for constructor's staff, home office, overhead, facilities
- ☐ (12)Engineering rework incentive
- ☐ (13)All inclusively hourly rate for all engineering functions
- ☐ (14)Contractor assumption of equity risk
- ☐ (15)Cost underrun sharing by contractor
- ☐ (16)Step function cost/schedule incentive matrix
- ☐ (17)All-or-nothing safety incentive
- ☐ (18)Plant downtime incentive
- ☐ (19)Capital budgeting effectiveness incentive
- ☐ (20)Craft worker productivity incentive (to contractor)
- ☐ (21)Safety incentive
- ☐ (22)Continuous improvement of incentive targets

1A. Please answer the following questions:

(1) Are you familiar with the Innovative Contractor Compensation concept?

Yes	☐
No	☐

(2) If so, how did you learn about the incentives?

_____

_____

(3) Used in the past 5 years?

Yes	☐
No	☐

(4) Trend in use?

Same	☐
More	☐
Less	☐

(5) Degree of use in past 5 years (% of Projects)?

0 - 25	☐
26 - 50	☐
51 - 75	☐
76 - 100	☐

Assess impact of incentive in use as applicable to areas 6 - 10. Refer to incentive list as necessary (pages 1-2).

[+3 +2 +1 0 -1 -2 -3]

"Positive" ← "Neutral" → "Negative"

Incentive #	(6) Quality	(7) Cost	(8) Schedule	(9) Safety
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Incentive #	(6) Quality	(7) Cost	(8) Schedule	(9) Safety
16				
17				
18				
19				
20				
21				
22				

1B. Please answer the following questions.

(1) Are you familiar with the Contractor Compensation concept?

Yes ☐
No ☐

(2) If yes, was a deliberate decision made not to use the concept? Please elaborate on the basis for the decision.

_____

_____

_____

_____

2. Of the 22 incentives, please identify the top three that are most effective in your organization. Please elaborate on their effectiveness and provide examples as they apply to specific jobs.

1. _____

_____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

_____

3. Do you use multiple incentives on individual projects?

Yes	☐
No	☐

Please elaborate on why and which combinations are in use?

Why? _____

_____

_____

Which combinations? _____

_____

4. Are you familiar with the CII products?

Yes	☐
No	☐

Please assess the usefulness of each of the CII products as indicated below.

[3 2 1 0]

"High Use" ◄——— "No Use"

CII Document #		Title	Score
1		Benchmarking & Metrics Summary Report for 1997	
2	Source Document SD-8	Incentives in Construction Contracts (1986)	
3		CII Benchmarking & Metrics Data Report for 1997	
4		"Use of Incentives," CII Conference Implementation Packet (1995)	
5		"Innovative Contractor Compensation Plans," CII Conference Packet (1996)	
6	SD-40	"Unique Features of Construction Contract Incentive Plans" (1988)	
7	Research 114-11	"Innovative Strategies for Contractor Compensation" (January 1998)	
8	CII Publ. 5-2	"Incentive Plans: Design & Application Considerations" (November 1988)	
9	CII Publ. 5-1	"Impact of Various Construction Contract Types and Clauses on Project Performance" (July 1996)	

CII Document #		Title	Score
10	Education Module EM 114-21	Innovative Contractor Compensation Strategies (1998)	
11	RS 114-1	Innovative Contractor Compensation (June 1998)	
12	Video Tape VC-612	Innovative Contractor Compensation Strategies (August 1996)	
13	VC-503	Use of Incentives (August 1995)	

5. Additional Comments?

_____

_____

_____

_____

_____

6. Would you be available for a follow-up discussion? Additional references?

_____

_____

_____

_____

Appendix C

SOURCE DATA FOR CHARACTERIZATION OF INCENTIVE USE BY CII MEMBER COMPANIES

Incentive Use Data (Binary Scale)

Own/Ctr	Use?	I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12
	1	0	1	0	0	0	1	1	1	0	1	1	1
	1	1	0	0	0	1	1	0	1	0	1	1	0
	1	0	0	0	0	0	1	0	0	0	0	1	0
	1	0	0	0	0	0	0	0	1	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	1	1
	1	1	0	1	1	0	0	1	1	0	1	1	0
	1	1	0	0	1	1	1	0	1	0	1	1	1
	1	1	0	0	1	1	1	1	1	1	1	1	1
	1	1	0	0	0	0	1	1	1	1	0	0	0
	1	1	0	0	1	1	1	0	1	1	1	0	1
	1	1	0	1	1	1	1	1	1	1	1	1	1
	1	0	1	0	0	1	0	0	1	0	0	0	0
	1	0	0	1	0	0	1	0	0	1	0	1	0
	1	0	0	0	1	0	0	0	1	1	0	1	0
	1	0	0	0	0	0	0	1	1	0	0	0	0
	1	0	0	0	0	0	1	1	1	0	1	1	0
	1	0	0	0	1	0	0	0	1	0	1	0	0
	1	0	0	0	1	0	1	1	1	1	1	1	1
	1	1	0	1	0	1	1	1	1	1	0	1	1
	1	1	0	0	0	1	1	1	0	0	0	1	0
	1	0	0	1	0	1	0	1	1	0	1	1	1
	1	0	0	0	0	1	1	0	1	0	1	1	0
C3	1	1	0	0	0	0	1	0	1	0	0	0	0
C14-1	1	0	0	0	1	0	1	0	1	1	1	1	1
C14-2	1	1	0	0	0	1	1	1	1	1	1	1	0
C17	1	0	0	0	0	1	1	1	1	0	1	1	0
C21-1	1	0	0	0	0	0	1	1	1	0	0	0	0
C21-2	1	0	0	0	0	0	0	1	1	0	1	1	0
C22	1	0	0	0	0	1	1	0	0	0	1	0	0
C27	1	0	1	0	1	0	1	1	1	1	1	1	0
C28-1	1	1	0	0	1	1	1	1	1	1	1	0	0
C28-2	1	1	0	0	1	1	1	1	1	1	1	0	0
C30	1	0	0	1	0	0	1	1	1	1	1	0	0
C35	1	1	0	0	1	1	1	0	1	0	1	1	0
C37	1	1	1	0	0	0	1	1	1	0	0	0	0
C38	1	1	1	1	1	1	1	1	1	1	1	1	1
SUM	36	16	5	7	14	17	27	21	31	15	23	23	11
% USE	100.00	44.44	13.89	19.44	38.89	47.22	75.00	58.33	86.11	41.67	63.89	63.89	30.56

Incentive Use Data (Binary Scale)

Own/Ctr	I13	I14	I15	I16	I17	I18	I19	I20	I21	I22
[redacted]	1	0	1	0	1	0	0	0	1	0
[redacted]	0	0	1	0	0	0	0	0	0	0
[redacted]	0	0	0	0	0	0	0	0	0	0
[redacted]	0	0	0	0	0	0	0	0	1	0
[redacted]	1	0	0	0	0	0	0	0	0	0
[redacted]	0	0	0	0	0	1	0	1	1	0
[redacted]	0	0	1	0	0	0	0	1	1	0
[redacted]	0	0	1	1	0	1	0	1	1	1
[redacted]	0	0	1	0	0	0	0	0	1	0
[redacted]	1	0	1	1	0	0	0	1	1	0
[redacted]	1	0	1	1	1	1	0	1	1	1
[redacted]	0	0	1	0	0	0	0	0	0	0
[redacted]	0	0	1	0	0	0	0	1	1	1
[redacted]	1	0	0	0	1	0	0	0	1	0
[redacted]	0	0	1	0	0	0	0	0	1	0
[redacted]	0	0	1	1	1	1	0	0	1	1
[redacted]	1	0	1	0	1	0	0	0	1	0
[redacted]	0	0	0	0	1	1	0	1	1	1
[redacted]	0	0	1	0	1	0	0	0	1	0
[redacted]	0	0	1	0	1	0	0	0	1	0
[redacted]	0	0	1	0	1	1	0	0	1	0
[redacted]	1	0	1	0	1	0	0	0	1	0
[redacted]	0	0	1	0	0	0	0	0	1	0
[redacted]	0	1	1	0	1	1	0	0	1	0
[redacted]	1	1	1	0	0	1	1	1	1	0
[redacted]	1	0	1	0	1	0	0	0	1	1
[redacted]	0	0	1	0	0	0	0	0	1	0
[redacted]	0	0	0	0	0	0	0	0	0	0
[redacted]	0	0	0	0	0	0	0	0	0	0
[redacted]	0	1	1	1	1	0	0	1	1	1
[redacted]	0	0	1	0	0	0	0	1	1	1
[redacted]	0	0	1	0	0	0	0	0	1	0
[redacted]	0	0	1	0	0	0	0	0	0	0
[redacted]	0	0	1	0	1	1	1	0	1	0
[redacted]	0	1	1	0	0	0	0	0	1	0
[redacted]	0	1	1	1	1	1	1	1	1	1
SUM	9	4	27	6	14	9	3	11	28	9
% USE	25.00	11.11	75.00	16.67	38.89	25.00	8.33	30.56	77.78	25.00

Incentive Impact on Cost (Scale -3 to +3)

Own/Ctr	I1C	I2C	I3C	I4C	I5C	I6C	I7C	I8C	I9C	I10C	I11C	I12C
		1				2	1	-1		1	-2	0
	1				1	1		1		3	1	
						0					0	
								2				
											2	1
	1		1	1			1	-1		1	1	
	3			3	1	1	1	1		1	3	1
	1	3		3	3	3	3	-3	-1	3	1	-3
	3					3	3	-2	0			
	1			0	-1	1		0	0	1		0
	3		1	3	2	3	1			3	1	1
		0			1			-1				
			1			1			1		0	
				2				3	3		3	
							2	0				
						2	2	0		3		
				3				2		3		
	1			2		1	1	0	0	1	0	1
	1		1		0	1	1	-2	-1		1	0
	2				3	3	2				3	
			2		1			1		1	1	
					2	2		2		2	-1	
C3	2					2		2				
C14-1	3	0	0	3	3	3	0	0	0	3	0	3
C14-2	3				3	3	2	0	0	3	0	
C17					1	2	2	-1		2	1	
C21-1						1	1	1				
C21-2							3	-1		3	0	
C22					3	2				2		
C27						2						
C28-1	2			2	1	2	2	-2		2		
C28-2	3	0		2	1	2	2	0	-1	2	-2	-2
C30			2			3	2	0	-1	2		
C35								3		2		
C37	3	3				3	1	2				
C38	1	3	0	3		3	3	0	0	3	0	3
MEAN	2.00	1.43	1.00	2.25	1.56	2.00	1.71	0.21	0.00	2.14	0.62	0.45

Incentive Impact on Cost (Scale -3 to +3)

Own/Ctr	I13C	I14C	I15C	I16C	I17C	I18C	I19C	I20C	I21C	I22C
	0		1		0				0	
			3							
	2									
						1		1	-1	
			3					0	0	
			3	1		2		1	1	2
			3						-1	
	1		1	1				2	0	
	0		3	3	-3	-3		3	-3	3
			2							
			1					0	-1	1
	2				0				2	
			3						2	
			3	3		0			2	3
	0		3		0				0	
					0	0		1	0	1
			3		0				0	
			3		2				2	
			1		1	2			1	
	0		1		0				1	
C3			1						0	
C14-1	1	3	3	2	-1	-1	3	1	-1	2
C14-2	0		3		0			0	1	
C17			2						1	
C21-1										
C21-2			3							
C22										
C27					1					3
C28-1			1					1	1	
C28-2	-1		1	2	-1	0	0	1	1	0
C30			2							
C35			2		3	3			2	
C37		3	3						0	
C38		3	3	3	0	0	3	3	0	3
MEAN	0.50	3.00	2.26	2.14	0.13	0.40	2.00	1.17	0.38	2.00

Incentive Impact on Quality (Scale -3 to +3)

Own/Ctr	I1Q	I2Q	I3Q	I4Q	I5Q	I6Q	I7Q	I8Q	I9Q	I10Q	I11Q	I12Q
		2				0	0	0		0	0	2
	0				0	0		0		0	0	
						1					1	
								1				
											0	1
	1		1	1			1	-1		-1	0	
	2			2	1	1	1	-1		-1	1	1
	-1	0		0	2	3	3	-3	2	-1	0	0
	1					1	1	0	1			
	0			0	0	0		0	2	0		1
	3		1	0	2	3	3		3	-3	0	2
		2			0			1				
			0			1			0		-1	
				2				2	2		0	
							1	0				
						0	2	-1		-1		
				0				0		0		
	2			0		1	2	0	2	1	0	1
	0		2		2	1	1	-1	2		0	0
	0				0	0	3				1	
			2		1			1		1	2	
					2	2		0		2	0	
C3	0					0		0				
C14-1	3	3	0	3	3	3	0	0	1	0	-1	3
C14-2	1				1	1	0	0	2	-2	-1	
C17					1	1	1	0		0	0	
C21-1						0	2	0				
C21-2							0	0		0	0	
C22					1	2				0		
C27						2						
C28-1	3			1	1	1	2	-1		0		
C28-2	3	0		0	0	1	0	0	1	0	-1	0
C30			0			2	2	0	2	0		
C35								0		0		
C37	2	3				2	2	0				
C38	1	3	0	3		3	1	0	3	3	0	3
MEAN	1.24	1.86	0.75	1.00	1.06	1.23	1.33	-0.10	1.77	-0.09	0.05	1.27

Incentive Impact on Quality (Scale -3 to +3)

O/C	I13Q	I14Q	I15Q	I16Q	I17Q	I18Q	I19Q	I20Q	I21Q	I22Q
	-1		0		0				0	
			0							
	1									
						0		-1	0	
			1					0	1	
			-2	0		3		-1	2	3
			0						0	
	0		0	0				1	0	
	0		-3	-3	-3	3		-3	-3	3
			1							
			-1					-1	-1	1
	2				2				2	
			0						0	
			-1	-1		-1			2	2
	0		0		0				0	
					0	1		1	0	1
			-1		1				1	
			1		0				0	
			1		1	1			1	
	-1		1		0				1	
C3			0						0	
C14-1	0	-2	0	0	0	0	0	-1	0	1
C14-2	0		-1		0			0	1	
C17			0						0	
C21-1										
C21-2			0							
C22										
C27					0					3
C28-1			1					1	1	
C28-2	-1		1	0	0	0	1	0	1	0
C30			0							
C35			0		0	0			0	
C37		2	3						0	
C38		1	0	0	0	3	0	3	0	3
MEAN	0.00	0.33	0.04	-0.57	0.07	1.00	0.33	-0.08	0.35	1.89

Incentive Impact on Safety (Scale -3 to +3)

O/C	I1Sa	I2Sa	I3Sa	I4Sa	I5Sa	I6Sa	I7Sa	I8Sa	I9Sa	I10Sa	I11Sa	I12Sa
[redacted]		0				1	0	0		0	0	0
[redacted]	0				0	0		0		0	0	
[redacted]						0					0	
[redacted]								3				
[redacted]											0	0
[redacted]	1		1	1			1	-1		-1	0	
[redacted]	2			2	2	1	0	0		-2	0	0
[redacted]	-3	3		3	3	3	3	-2	0	0	-1	0
[redacted]	2					2	2	-1	0			
[redacted]	0			1	0	0		0	0	0		0
[redacted]	3		1	3	3	3	0			-3	0	0
[redacted]		3			0			0				
[redacted]			0			1			1		0	
[redacted]				0				2	2		1	
[redacted]							2	0				
[redacted]						3	2	0		0		
[redacted]				0				0		0		
[redacted]	3			2		1	0	0	0	0	0	0
[redacted]	3		2		3	1	1	-2	0		0	0
[redacted]	3				3	3	1				0	
[redacted]			2		1			2		1	1	
[redacted]					3	3		0		2	1	
C3 [redacted]	2					1		0				
C14-1 [redacted]	3	3	0	3	3	3	0	-1	0	0	-1	0
C14-2 [redacted]	1				0	1	0	0	0	-1	0	
C17 [redacted]					2	2	1	0		0	0	
C21-1 [redacted]						1	0	0				
C21-2 [redacted]							0	0		0	0	
C22 [redacted]					2	2				0		
C27 [redacted]						2						
C28-1 [redacted]	3			1	1	2	2	0		1		
C28-2 [redacted]	3	0		1	2	1	1	0	0	1	-1	0
C30 [redacted]			0			0	1	0	0	0		
C35 [redacted]								0		0		
C37 [redacted]	3	3				3	2	0				
C38 [redacted]	1	3	0	3		3	1	0	0	0	0	0
MEAN	1.76	2.14	0.75	1.67	1.75	1.65	0.95	0.00	0.25	-0.09	0.00	0.00

Incentive Impact on Safety (Scale -3 to +3)

O/C	I13Sa	I14Sa	I15Sa	I16Sa	I17Sa	I18Sa	I19Sa	I20Sa	I21Sa	I22Sa
	0		0		0				1	
			0							
	0									
						0		0	2	
			0					0	3	
			-1	0		0		-1	3	2
			-1						2	
	0		0	0				0	1	
	0		-3	-3	3	-3		-3	3	3
			2							
			0					-1	2	0
	2				3				3	
			0						1	
			0	0		0			3	2
	0		0		2				3	
					1	0		1	2	1
			-1		3				3	
			2		3				3	
			1		0	1			1	
	0		1		1				2	
C3			0						2	
C14-1	0	0	3	0	3	-1	3	-1	3	2
C14-2	0		0		2			1	0	
C17			0						2	
C21-1										
C21-2			0							
C22										
C27					3					3
C28-1			0					1	1	
C28-2	0		0	1	0	0	0	0	1	0
C30			0							
C35			0		3	0			3	
C37		2	2						2	
C38		1	0	0	3	0	0	1	3	3
MEAN	0.20	1.00	0.19	-0.29	2.00	-0.30	1.00	-0.17	2.12	1.78

Incentive Impact on Schedule (Scale -3 to +3)

Own/Ctr	I1S	I2S	I3S	I4S	I5S	I6S	I7S	I8S	I9S	I10S	I11S	I12S
		1				1	1	2		1	-1	-1
	2				2	2		2		1	2	
						2					2	
								3				
											1	1
	1		1	1			1	2		1	0	
	1			1	2	1	0	1		1	1	1
	2	3		3	3	3	3	3	0	3	1	0
	3					3	3	3	0			
	0			0	2	1		1	0	1		0
	3		1	3	2	3	1	3		3	1	0
		0			2			2				
			1			1			1		-1	
				2				3	1		0	
							1	1				
						3	2	3		3		
				3				3		3		
	1			1		1	2	2	0	1	0	1
	3		1		2	1	1	2	-1		1	0
	0				1	2	3				0	
			2		2			3		1	1	
					3	3		3		3	0	
C3	2					2		2				
C14-1	3	0	0	0	3	3	0	3	0	3	2	0
C14-2	3				3	3	2	3	0	3	0	
C17					1	2	1	2		2	0	
C21-1						1	2	3				
C21-2							3	3		3	0	
C22					3	2				3		
C27						2						
C28-1	2			2	2	2	2	3		2		
C28-2	3	0		2	3	2	3	2	-1	2	0	-1
C30			2			3	2	2	0	2		
C35								3		2		
C37	2	2				2	2	3				
C38	1	3	0	3		3	3	3	0	3	0	1
MEAN	1.88	1.29	1.00	1.75	2.25	2.08	1.81	2.47	0.00	2.14	0.48	0.18

Incentive Impact on Schedule (Scale -3 to +3)

Own/Ctr	I13S	I14S	I15S	I16S	I17S	I18S	I19S	I20S	I21S	I22S
	0		1		0				0	
			1							
	1									
						2		1	0	
			2					0	0	
			-1	1		-2		1	1	2
			-1						-1	
	0		1	1				2	0	
	0		-3	3	-3	-3		1	-3	3
			1							
			0					1	0	1
	0				0				0	
			0						1	
			-1	-3		3			0	3
	0		2		0				0	
					0	2		1	0	1
			1		0				0	
			2		1				1	
			1		1	2			1	
	0		1		0				1	
C3			-2						0	
C14-1	0	1	3	2	-1	3	3	3	-1	2
C14-2	0		-1		0			0	1	
C17			-1						1	
C21-1										
C21-2			3							
C22										
C27					0					3
C28-1			1					2	1	
C28-2	-1		1	2	-1	2	0	1	1	0
C30			0							
C35			2		0	3			0	
C37		2	2						0	
C38		3	0	3	0	0	0	3	1	3
MEAN	0.00	2.00	0.56	1.29	-0.20	1.20	1.00	1.33	0.19	2.00

Composite Impact on Cost, Quality, Safety, and Schedule

Incentives	Mean Sum	Scaled Value
I1	6.88	77.27
I2	6.71	75.33
I3	3.50	39.29
I4	6.67	74.88
I5	6.63	74.43
I6	6.96	78.14
I7	5.81	65.23
I8	2.57	28.85
I9	2.02	22.68
I10	4.09	45.92
I11	1.14	12.80
I12	1.91	21.44
I13	0.7	7.86
I14	6.33	71.07
I15	3.04	34.13
I16	2.57	28.85
I17	2	22.45
I18	2.3	25.82
I19	4.33	48.61
I20	2.25	25.26
I21	3.04	34.13
I22	7.67	86.11

The scaled value was calculated by multiplying the mean sum by a factor of 11.23. The factor was derived by normalizing both incentive use and composite impact scales.

Appendix D

RELEVANT QUESTIONS FROM CII BM&M QUESTIONNAIRE

CII Benchmarking and Metrics
Contractors (Version 3.0)

The data collected by this form begins the third round of data collection for CII's benchmarking and metrics system. The data will be used to establish performance norms, to identify trends, and to correlate execution of project management processes to project outcomes. It will form part of a permanent database. Through such correlation across many companies and projects, opportunities for improving your company's project performance will be identified. Following the data collection and metrics calculations, each company will be provided project and company aggregate key reports for comparison with the database benchmarks. It is important that you retain a copy of this questionnaire for your records and future analysis. **All data will be held in strict confidence.**

When you have completed the questionnaire, please return it to your Company's Benchmarking Associate by **June 1, 1998.**

The next 2 pages contain definitions for project phases. Please pay particular attention to the start and stop points highlighted. All project costs should be given in U.S. dollars. If you need further assistance in interpreting the intent of a question, please call Steve Thomas CII at (512) 232-3007 (E-mail: sthomas@mail.utexas.edu) or Marvin Oey CII at (512)232-3051 (E-mail: marvinoey@mail.utexas.edu). Conformance to the instructions and phase definitions is crucial for establishing reliable benchmarks.

Your Company Benchmarking Associate has been provided with a list of projects that were submitted by your company during the previous data

collection effort. To maintain the integrity of the database, please ensure that projects that were submitted previously are not reported again.
If the information required to answer a given question is not available, please write "UNK" (unknown) in the space provided. If the information requested does not apply to this project, please write "NA" (not applicable) in the space provided. Keep in mind, however, that too many "unknowns" or "not applicable" could render the project unusable for analysis.

This questionnaire should be completed under the direction of the project manager in consultation with colleagues who worked on the project. Again, please carefully review the phase table on the next 2 pages before attempting to provide the requested information.

1. Your Company: _____

2. Your Project I.D. _____ (You may use any reference to protect the project's identity. The purpose of this I.D. is to help you and CII personnel identify the questionnaire correctly if clarification of data is needed and to prevent duplicate project entries.)

3. Project Location: Domestic _____ , USA
State

International _____
Country

4. Contact Person (name of the person filling out this form): _____

5. Contact Phone No. (____) _____ **6.** Contact Fax No. (____) ___
E-mail address _____

7. Principal Type of Project

Check only one. If you feel the project does not have a principal type, but is an even mixture of two or more of those listed, please attach a short description of the project. If the project type does not appear in the list, please describe in the space next to "Other.":

Industrial	Infrastructure	Buildings
_____Electrical (Generating)	_____Electrical Distribution	_____Lowrise Office
_____Oil Exploration/Production		
_____Highway	_____Highrise Office	
_____Oil Refining	_____Navigation	_____Warehouse
_____Pulp and Paper	_____Flood Control	_____Hospital
_____Chemical Mfg.	_____Rail	_____Laboratory
_____Environmental	_____Water/Wastewater	_____School
_____Pharmaceuticals Mfg.	_____ Airport	_____Prison
_____Metals Refining/Processing		_____Tunneling
_____Consumer Products Mfg.	_____Mining	_____Parking Garage
_____Natural Gas Processing		_____Retail
_____Automotive Mfg.		
_____Foods		

_____Other (Please describe)_____

8. This project was (check only one): Grass Roots_____

Modernization _____ Addition _____

Grass roots - a new facility from the foundations and up. A project requiring demolition of an existing facility before new construction begins is also classified as grass roots.

Modernization - a facility for which a substantial amount of the equipment, structure, or other components is replaced or modified, and which may expand capacity and/or improve the process or facility.

Addition - a new addition that ties in to an existing facility, often intended to expand capacity.

_____ Other (Please describe)_____

9. Please indicate if the Owner of this project is a CII member or non-member company. The last page of the glossary contains a CII membership list.

CII Member _____

non-member _____

10. Please indicate in the table below the function(s) **your company** performed on this project and the approximate percent of each to the nearest 10%. For each function, indicate the principle form of remuneration in use at the completion of the work. Also indicate if your contract contained incentives. Use a separate line for each function your company performed.

Please use the following codes to identify the **Function(s)** performed by your company.

PPP	Pre-Project Planner	DM	Demolition/Abatement Contractor
PPC	Pre-Project Planning Consultant	GC	General Contractor
D	Designer	PC	Prime Contractor
PE	Procurement - Equipment	SC	Subcontractor
PB	Procurement - Bulks	PM	Project Manager
		CM	Construction Mgr

Percent of Function refers to the percent of the overall function contributed by your company. Estimate to the nearest 10 percent.

Type of Remuneration refers to the overall method of payment. Unit price refers to a price for in place units of work and does not refer to hourly charges for skill categories or time card mark-ups. Hourly rate payment schedules should be categorized as cost reimbursable. Please use the following codes to identify remuneration type.

LS	Lump Sum	CR	Cost Reimbursable/Target Price (Including Incentives)
UP	Unit Price	GP	Guaranteed Maximum Price

If **Incentives** were utilized in your company's contract, please indicate whether those incentives were positive (a financial incentive for attaining an objective), negative (a financial disincentive for failure to achieve an objective), or both. Circle "+" to indicate a positive incentive and circle "-" to indicate a negative incentive.

Function	Approx. Percent of Function (Nearest 10%)	Type of Remun. (Contract End)	Contract Incentives (circle as many as apply)							
			Cost		Schedule		Safety		Quality	
			+	-	+	-	+	-	+	-
			+	-	+	-	+	-	+	-
			+	-	+	-	+	-	+	-
			+	-	+	-	+	-	+	-
			+	-	+	-	+	-	+	-

10A. Is your company an ***Alliance Partner*** with the owner of this project?

Appendix E

SOURCE DATA FOR QUANTITATIVE CHARACTERIZATION OF INCENTIVE USE BY CII MEMBER COMPANIES (BM&M VERSION 3.0)

CII_ID	FUNCTION	COST_INC	QUAL_INC	SAFE_INC	SCHD_INC	COUNTRY	TYPE	CHAR
C158	CM	+	+	+	+	USA	Chemical Mfg.	Modernization
C159	GC	+	+	+	+	USA	Chemical Mfg.	Grass Roots
C160	GC	+	+	+	+	USA	Chemical Mfg.	Grass Roots
C139	PM	+	None	None	+	USA	Consumer Products Mfg.	Add on
C139	CM	+	None	None	+	USA	Consumer Products Mfg.	Add on
C143	CM	+	+	+	+	USA	Consumer Products Mfg.	Add on
C145	CM	+	None	None	None	USA	Foods	Add on
C145	GC	+	None	None	None	USA	Foods	Add on
C182	PC	-	None	-	-	USA	Chemical Mfg.	Add on
C174	GC	None	None	None	-	USA	Pulp and Paper	Add on
C163	PM	+	+	+	+	USA	Chemical Mfg.	Add on
C163	CM	+	+	+	+	USA	Chemical Mfg.	Add on
C147	PM	+	None	None	+	USA	Pulp and Paper	Add on
C188	PM	+	+	+	+	USA	Foods	Grass Roots
C188	CM	+	+	+	+	USA	Foods	Grass Roots
C188	GC	+	+	+	+	USA	Foods	Grass Roots
C148	GC	None	None	None	+	USA	Pulp and Paper	Add on
C218	GC	Both	None	None	None	USA	Metals Refining/Process-ing	Add on
C219	GC	+	None	None	None	USA	Retail Building	Grass Roots
C318	CM	-	-	-	-	USA	Foods	Add on
C326	PM	+	+	None	+	USA	Oil Exploration/Pro-duction	Add on

CII_ID	FUNCTION	COST_INC	QUAL_INC	SAFE_INC	SCHD_INC	COUNTRY	TYPE	CHAR
C326	CM	+	+	+	+	USA	Oil Exploration/Pro-duction	Add on
C330	PC	+	+	+	+	USA	Chemical Mfg.	Modernization
C399	PM	+	+	None	-	United Kingdom	Natural Gas Processing	Add on
C343	GC	+		+	+	USA	Laboratory	Add on
C343	PM	+		+	+	USA	Laboratory	Add on
C369	GC	+	None	None	+	Netherlands	Pharmaceuticals Mfg.	Add on
C370	GC	+	+	+	+	USA	Environmental	Grass Roots
C373	CM	+			+	USA	Chemical Mfg.	Add on
C374	CM	+	None	None	+	USA	Pharmaceuticals Mfg.	Grass Roots
C375	PC	+				USA	Foods	Add on
C376	PC	+	+	+	+	USA	Environmental	Grass Roots
C376	PM	+	+	+	+	USA	Environmental	Grass Roots
C376	CM	+	+	+	+	USA	Environmental	Grass Roots
C377	PC	+	+	+	+	USA	Environmental	Grass Roots
C377	PM	+	+	+	+	USA	Environmental	Grass Roots
C377	CM	+	+	+	+	USA	Environmental	Grass Roots
C347	PC	Both				USA	Metals Refining/Process-ing	Add on
C390	GC	+	+	+	+	USA	Chemical Mfg.	Add on
O114	CM	None	+	+	+	France	Chemical Mfg.	Add on
O115	GC	+	+	+	+	USA	Chemical Mfg.	Grass Roots
O115	CM	+	+	+	+	USA	Chemical Mfg.	Grass Roots
O117	GC	Both	None	Both	None	USA	Chemical Mfg.	Modernization

CII_ID	FUNCTION	COST_INC	QUAL_INC	SAFE_INC	SCHD_INC	COUNTRY	TYPE	CHAR
O110	GC	+	+	+	+	USA	Metals Refining/Process-ing	Grass Roots
O110	PC	+	+	+	+	USA	Metals Refining/Process-ing	Grass Roots
O110	PM	+	+	+	+	USA	Metals Refining/Process-ing	Grass Roots
O110	CM	+	+	+	+	USA	Metals Refining/Process-ing	Grass Roots
O111	GC	Both	Both	Both	Both	USA	Metals Refining/Process-ing	Modernization
O111	PM	Both	Both	Both	Both	USA	Metals Refining/Process-ing	Modernization
O111	PM	Both	Both	Both	Both	USA	Metals Refining/Process-ing	Modernization
O111	CM	Both	Both	Both	Both	USA	Metals Refining/Process-ing	Modernization
O128	GC	None	None	None	Both	USA	Pharmaceuticals Mfg.	Grass Roots
O143	CM	+	+	+	+	USA	Chemical Mfg.	Grass Roots
O143	PC	+	+	+	+	USA	Chemical Mfg.	Grass Roots
O143	PC	Both	Both	Both	Both	USA	Chemical Mfg.	Grass Roots
O146	PC	+	None	+	+	Singapore	Oil Refining	Add on
O146	PC	+	None	+	+	Singapore	Oil Refining	Add on

CII_ID	FUNCTION	COST_INC	QUAL_INC	SAFE_INC	SCHD_INC	COUNTRY	TYPE	CHAR
O147	CM	Both	-	-	Both	The Netherlands	Oil Refining	Add on
O148	CM	+	-	-	+	Italy	Oil Refining	Add on
O150	GC	Both	Both	Both	Both	USA	Pulp and Paper	Add on
O174	CM	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	Both	USA	Oil Refining	Add on
O174	PC	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	-	USA	Oil Refining	Add on
O174	PC	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	-	USA	Oil Refining	Add on
O174	PC	None	None	+	None	USA	Oil Refining	Add on
O174	PC	None	None	+	-	USA	Oil Refining	Add on
O174	PC	None	None	+	-	USA	Oil Refining	Add on
O172	GC	Both	+	+	Both	USA	Oil Refining	Modernization
O177	GC	-	+	+	-	USA	Chemical Mfg.	Modernization
O176	CM	None	+	None	None	USA	Chemical Mfg.	Add on
O176	GC	None	None	+	None	USA	Chemical Mfg.	Add on
O179	PC	None	None	+	None	USA	Water/Waste-water	Grass Roots
O196	CM	Both	None	None	Both	Canada	Chemical Mfg.	Add on
O196	PM	Both	None	None	Both	Canada	Chemical Mfg.	Add on
O315	PC	Both		Both	Both	USA	Metals Refining/Process-ing	Add on
O316	GC	Both		Both	Both	USA	Metals Refining/Process-ing	Modernization

CII_ID	FUNCTION	COST_INC	QUAL_INC	SAFE_INC	SCHD_INC	COUNTRY	TYPE	CHAR
O317	GC	Both				USA	Metals Refining/Process-ing	Add on
O318	GC	Both		+		USA	Metals Refining/Process-ing	Modernization
O319	PC	Both		+		USA	Metals Refining/Process-ing	Modernization
O341	GC				+	USA	Pulp and Paper	Modernization
O351	GC	+		+	+	USA	Oil Refining	Modernization
O351	GC	+		+	+	USA	Oil Refining	Modernization
O352	PC	+		+	+	Argentina	Oil Refining	Add on
O353	GC	Both	Both	Both	Both	Canada	Oil Refining	Grass Roots
O354	PC	+		-	+	Singapore	Oil Refining	Modernization
O354	PM	+		-	+	Singapore	Oil Refining	Modernization
O354	CM	+		-	+	Singapore	Oil Refining	Modernization
O355	PC	-	-	-	+	Italy	Oil Refining	Grass Roots
O356	PC	-	-	-	+	Italy	Oil Refining	Grass Roots
O303	CM	Both			Both	USA	Lowrise Office	Modernization
O304	CM	-	-	-	+	USA	Chemical Mfg.	Add on
O315	GC	Both		Both	Both	USA	Metals Refining/Process-ing	Add on
O439	CM	Both	+	+	+	Sweden	Chemical Mfg.	Grass Roots

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Vita

Jeffrey Larry Milhorn was born in Ames, Iowa on April 7, 1967, the son of Phyllis and Larry Milhorn. He grew up with his sister, Teri, as a military dependent traveling throughout the United States and Europe. He graduated in 1985 as Valedictorian of his senior class from Leavenworth Senior High School. In August of 1985 he entered into the freshman class at the University of Florida in Gainesville, Florida, with a four-year Army Reserve Officer Training Corps (ROTC) Scholarship. At the University of Florida, he studied Civil Engineering and graduated as a Distinguished Military Graduate in August of 1990. He received a Bachelor of Science Degree in Civil Engineering and was commissioned as a Second Lieutenant in the United States Army Corps of Engineers. He served in a variety of troop assignments to include Support Platoon Leader in South Korea, Platoon Leader and Company Executive Officer in the 82nd Airborne Division, and Company Commander in the 25th Infantry Division. His military awards and decorations include the Meritorious Service Medal, the Army Commendation Medal with Oak Leaf Cluster, the Army Achievement Medal with Oak Leaf Cluster, the Master Parachutist and Air Assault Badges, and the Ranger Tab.

Jeffrey is married to Deborah Renee' Milhorn, formerly of Mountain Home, Arkansas. They have a son, Chase, and two daughters, Lindsay and Kailey.

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